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CONTENTS.

	PAGE
Whale Models at the Natural History Museum. By R. LYDEKKER, B.A., F.R.S. (*Illustrated*)	193
Repetition and Evolution in Bird-Song. By CHARLES A. WITCHELL	196
The Karkinokosm, or World of Crustacea.—V. By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S. (*Illustrated and Plate*)	197
Economic Botany. By JOHN R. JACKSON, A.L.S., etc. ...	199
British Ornithological Notes. Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.	202
Letters:—DAVID FLANERY (*Illustrated*); H. W. M. LAGERWEY, LL.D.; ARTHUR EAST	203
Science Notes	204
Variable Stars of Short Period. By EDWARD C. PICKERING. (*Illustrated*)	205
The Astronomy of the "Canterbury Tales." By E. WALTER MAUNDER, F.R.A.S.	205
Notices of Books	207
SHORT NOTICES	209
BOOKS RECEIVED	209
"Insect Miners."—II. By FRED. ENOCK, F.L.S., F.E.S., etc. (*Illustrated*)	209
Botanical Studies.—V. Asplenium. By A. VAUGHAN JENNINGS, F.L.S., F.G.S. (*Illustrated*)	211
Notes on Comets and Meteors. By W. F. DENNING, F.R.A.S.	213
The Face of the Sky for September. By A. FOWLER, F.R.A.S.	214
Chess Column. By C. D. LOCOCK, B.A.	215

WHALE MODELS AT THE NATURAL HISTORY MUSEUM.

By R. LYDEKKER, B.A., F.R.S.

ALTHOUGH many of us have from time to time witnessed the evolutions of a shoal of porpoises from some seaside pier, or the deck of a coasting vessel, while more fortunate individuals have enjoyed the spectacle of a whale rising from the water by the side of an ocean steamer, or have seen a stranded specimen on the beach, to the majority of landsmen the larger members of the Cetacean order have hitherto been more or less mysterious creatures. Their proper form and size have been but vaguely realized, and their peculiarities of structure most imperfectly conceived. Not improbably there are still in existence persons whose knowledge of whales is mainly, if not exclusively, limited to "whalebone" and sperm-whale teeth, and who have some vague idea that the two are products of one and the same animal. A year or so ago anyone who visited even the most advanced and up-to-date museum would have come away with little more idea of the external form and dimensions of these mighty denizens of the deep than the misleading and unsatisfactory impressions that can be gathered from a study of their bare skeletons. It is true that in some Continental museums, like the one in Paris, casts of stranded examples of some of the smaller species have for some time been exhibited, but the distorted and "flabby" condition of the animals themselves when thrown ashore rendered the resulting plaster-casts very far indeed from affording a lifelike representative of the species, while their comparatively small size precluded the realization of the vast dimensions attained by the giants of the group.

This unsatisfactory condition of affairs has been totally changed by the opening on Whit Monday last of the new Whale Gallery in the Natural History Branch of the British Museum. Here, for the first time in the history of the world, may be seen some of the largest representatives of the Cetacean order modelled of the natural size, and as lifelike in appearance as the resources of modern skill and science can make them. The exhibition is indeed a truly marvellous one, and its conception and successful execution will remain as a permanent memorial of the administration of Sir W. H. Flower, whose great aim has been to make the great institution under his charge as popular and instructive as possible, and under whose immediate personal superintendence the present addition was carried out from first to last.

From an educational point of view the value of the new exhibition cannot be over estimated; from a purely popular standpoint, as a "show," it will be very hard indeed to beat; while even to the professed naturalist it is of the highest interest, and presents several problems still requiring elucidation as to details of form in one or two species, Mystery in regard to our conceptions of the form of these huge denizens of the deep is, however, practically at an end; and for the future there ought to be no misconception as to the nature and position in the body of the substances respectively known as whalebone and spermaceti, and the animals to which they severally belong. Much importance has been rightly attached by the Director to an adequate supply of carefully-written descriptive labels, and these have been placed in positions convenient for the study of the groups or species to which they refer. The labels are of two kinds—large and small; the former referring to groups and the latter to particular species. Of the large labels, all of which are affixed in conspicuous positions on the walls of the buildings, the first gives in popular form the leading distinctive features of the order Cetacea, which, it is almost needless to observe, includes not only the animals commonly known as whales, but likewise porpoises, grampuses, and dolphins. The first point necessary to a right comprehension of the mutual relations of these animals is to thoroughly realize the difference between the whalebone whales and the toothed whales, or those which produce whalebone, or baleen, and those whose mouths are simply armed with teeth, of larger or smaller size and number. To emphasize the distinction, the whalebone whales, whether models or skeletons, have all been set up with their heads pointing to the north end of the gallery, while all the toothed whales are turned in the opposite direction; the distinctive features of the two groups being likewise clearly set forth in large labels on the walls. Yet another set of similar sized labels enables the public to grasp the difference between right-whales and rorquals; while the characteristics of the individual species exhibited are displayed on smaller labels mounted on stands placed in front of the specimens to which they refer.

Those of our readers who have seen the gallery (and it may be hoped that those who have not will take the earliest

opportunity of doing so) will not fail to realize how cleverly economy of space and material has been effected in the construction of the models. This has been done by taking the mounted skeleton of the specimen to be operated upon, and building upon one side of it a hollow half-model of the external form. As the right side of the body has been thus modelled in the whalebone whales, and the left side in the toothed whales, it results from this ingenious plan that whereas the visitor on entering the gallery sees the external form of the species that have been modelled, when he moves to the opposite side he is confronted with a view of the skeleton surrounded by the outline of the bodily contour. By this means not only are the skeletons as accessible as before for the purposes of anatomical study, but the relationship of their component portions to the bodily form is most clearly displayed. Accuracy in the modelling has been secured from the circumstance that the skeletons of most, if not all of the specimens, are those of stranded individuals, whose form and proportions have been recorded while in the flesh from measurements and drawings or photographs.

In its present condition the gallery contains models of six of the larger species, namely, the southern right whale (*Balæna australis*), Rudolphi's rorqual (*Balænoptera borealis*), and the common rorqual (*Balænoptera musculus*), among the whalebone whales; and the gigantic sperm whale (*Physeter macrocephalus*), the killer (*Orca gladiator*), and the white whale (*Delphinapterus leucas*), among the toothed whales. Of these, the killer differs from the others in that it is represented by a complete model, alongside of which is mounted the bare skeleton. The first of the four larger models attempted was that of Rudolphi's rorqual, which was undertaken somewhat as an experiment to see how the idea would work. As this is a comparatively small species (scarcely reaching fifty feet in length at its maximum) it obviously did not give an adequate idea of the huge dimensions attained by other members of the group, and, consequently, a model of the much larger common rorqual was subsequently executed. This accounts for the circumstance that while the rorquals are represented in the gallery by two species, there is at present no model of the allied but very different hump-backed whale (*Megaptera*), for which room does not now remain. But it may be hoped that an extension of the limits of the building may ere long admit of this very important species being added to the exhibition.

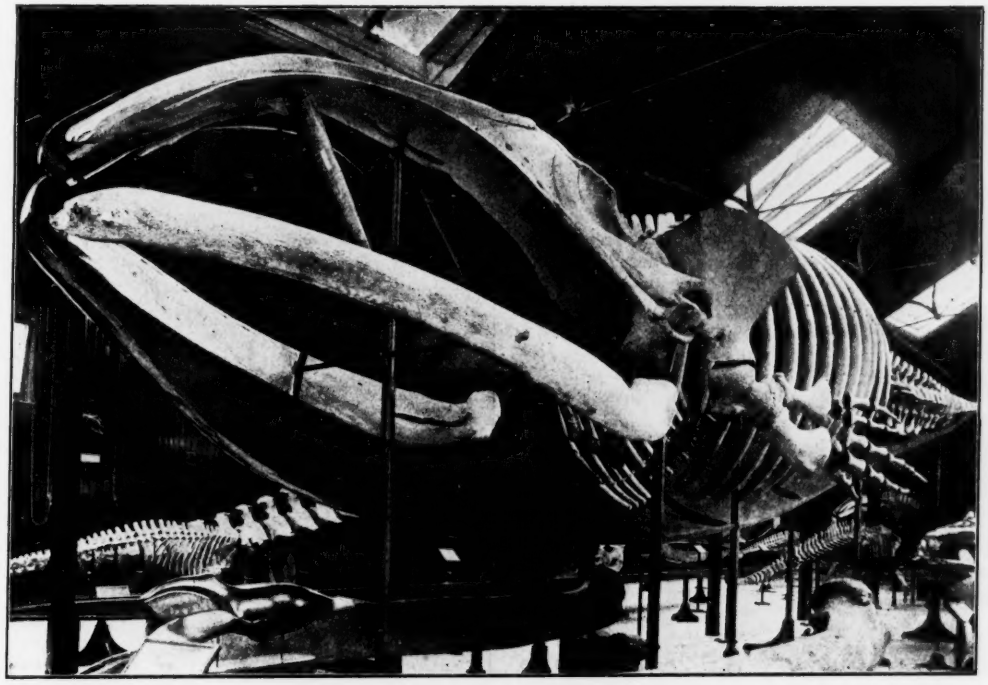
The finners, or rorquals, are noted among whalers for their extreme speed, and, consequently (especially as their short whalebone is of but little value), escaped persecution until the introduction of steam vessels and harpoon guns; and the models, in comparison with the one of the southern right-whale, clearly show how their long slender bodies are adapted for the attainment of such rapidity of movement. In these specimens the whalebone has been placed in its natural position in the skull, and thereby exhibits its characteristic shortness. Another feature shown almost for the first time in these models is the capacious distensible pouch occupying the throat of the rorquals, the flexible longitudinal bands in the pouch constituting the characteristic groovings seen in the skin of this part of these animals. On the skeletal aspect of the common rorqual the tiny bony nodule, which alone represents the thigh-bone, or femur of ordinary mammals, can scarcely fail to arrest attention, and affords a most interesting example of a rudimentary, or, rather, vestigiary organ. Although the common rorqual, which grows to sixty-five or seventy feet in length, is not the largest member of the group, being exceeded in this respect by the blue rorqual (*B. sibbaldi*), which reaches eighty or even eighty-five feet, yet the model in the gallery serves to show that very exaggerated ideas of the dimensions attained by these monsters formerly prevailed, and even yet do not appear wholly extinct. And it may be hoped that with the opening of this gallery to the public we shall hear the last of blue rorquals measuring a couple of hundred feet in length.

Passing on from the model of the common rorqual to that of the black or southern right-whale, the visitor will have impressed on his memory the essential difference between a rorqual and a right-whale in a manner never to be forgotten. The contrast between the comparatively short and thick body of the latter, its narrow and vaulted upper jaw, the highly convex border of the enormously deep lower lip, and, above all, the immense space left between the upper and lower jaws for reception of the huge plates of whalebone, and the corresponding proportions of the rorqual are apparent at a single glance, and appear more wonderful still on minute inspection. A few of the whalebone plates belonging to the skeleton of the model have fortunately been preserved, and are inserted in their approximate position in the upper jaw; and it is probable that this is the only idea that the public will ever gain of what the fully-armed mouth of a right-whale looks like in nature. Even if the present specimen possessed its full complement of whalebone, it would not come up to a Greenland right-whale similarly provided, for in that species the head is considerably larger and the whalebone plates are longer than in its southern relative. Plates of both species are exhibited on the wall adjacent; and an idea of the leading differences between the two forms may be gathered by comparing a small model, with the whalebone in position, of the Greenland species placed beneath the head of the southern kind. This small model was presented by Captain D. Gray, who, in the course of his numerous cruises, has done so much to acquaint us with the anatomy and habits of the Greenland right-whale. In addition to the features already mentioned, the small model shows the peculiar conformation of the lower lip, the marked constriction immediately in advance of the enormous "flukes," and the white areas on the lower lip, at the base of the flipper, at the root of the flukes, and round the eye, which form such striking marks of distinction between the northern and southern right-whales.

Beneath the head of the model of the southern right are placed the two halves of the lower jaw of a Greenland whale, which was evidently a much more gigantic animal than the specimen above. To this jaw a somewhat melancholy history attaches. Captain Gray had the laudable intention of procuring for the Museum the entire skull of the finest specimen of the fast-vanishing Greenland right-whale he could capture. In "Jubilee" year he had alongside his vessel the carcass of a splendid bull; after the whalebone and blubber had been removed, preparations for removing and hoisting on board the head were about to be taken, when, as ill-luck would have it, other whales hove in sight, and the boats' crews were of course in requisition. As a result of the interruption all that he saved of the skull was the lower jaw in the Museum. To make matters worse, neither of the whales which caused the diversion were secured. It was, I believe, the ambition of Captain Gray to see the skull exhibited with its whalebone in position in the Museum, but as the "bone" yielded by this particular specimen realized some two thousand pounds, financial considerations might have interfered with the accomplishment of his desire. There is, however, yet opportunity for some millionaire to present such a specimen to the Museum before the species becomes entirely extinct. And here I am reminded that those of my readers desirous of

becoming acquainted with the migrations of the Greenland right-whale, and the localities where it is still likely to be found, cannot do better than read a very interesting paper on this subject recently communicated by my friend Mr. T. Southwell to *Natural Science*.

Having given so much space to the whalebone whales but little remains for the toothed group. In this section, by far the most striking exhibit is the model of a male sperm whale, built upon the skeleton of a specimen stranded upon the British coasts. In addition to its vast corporeal bulk, as great if not greater than that of the Greenland right-whale, the most remarkable peculiarities are the enormous truncated head, at the front extremity of which is situated the single blow-hole, the powerful teeth with which the lower jaw is armed, the absence of a back fin, and the peculiar tuberosities on the middle line of the back somewhat in advance of the flukes. On the skeletal side of the specimen the visitor will be at once struck by the enormous size of the cavity containing the fine oil, which, on removal, solidifies into spermaceti; and will also wonder at the use of such a receptacle and its contents. Probably the oil is merely the most convenient material for filling a cavity rendered necessary by the peculiar conformation of the animal's head. Those of my readers who are intimately acquainted with the natural history of the sperm-whale may perhaps notice that the muzzle is made somewhat less truncated than is the case in many of the pictures of the animal; and naturalists are somewhat at issue with regard to the exact conformation of this portion of its body. All the old whalers are, however, in accord in representing the muzzle as broad and truncate as the front of a railway engine; and this peculiar and characteristic contour is shown in a rude sketch of the creature made by a whaler on one of its own teeth exhibited in a table-case in the gallery. Although some modern observers have stated that the muzzle is much less truncated and more or less pointed, it seems impossible to traverse the general accuracy of the testimony of whalers, so far at least as old bulls are concerned. And if there be any departure from this type it remains to be proved whether it is not due to age. Another moot point connected with the sperm-whale is its power to raise the lower jaw into the horizontal position without turning over on its back. The mucous membrane of the mouth is of a glistening white colour, and it has long since been asserted that, when on the feed deep down below the surface of the sea, the creature is in the habit of dropping its lower jaw and thus attracting prey within its glistening mouth. Whatever may be the truth of the latter part of the story, there seems no doubt that these whales are very generally in the habit of dropping the long lower jaw into a nearly vertical position, and some modern observers say that such is from necessity its habitual practice. Such a position would, however, be extremely inconvenient to reproduce in a model, and therefore no fault can be found with the restoration on the conventional lines. Here it may be mentioned that although the sperm-whale has long been known to feed on cuttles and squids, it has only recently been ascertained that the species preyed upon were of gigantic size. When harpooned these whales invariably disgorge their last meal, and some of the matter thus ejected has included portions of the arms of cuttle-fish measuring fully six feet in cube.



View in the New Whale Gallery at the Natural History Museum, with the skeleton and restoration of the Southern Right-Whale in the foreground.

Near by the sperm-whale model stands a mounted skeleton of the lesser sperm-whale (*Cogia breviceps*), a species differing from its larger relative by the much shorter jaws and proportionately smaller spermaceti cavity. It is, in fact, in one sense, a sperm-whale in course of evolution, not the least remarkable feature in its anatomy being the marked dissimilarity in the size of the two nasal apertures in the skull. It may be hoped that

means will be found for making models of the bottle-nose *Hyperöodon* and of one of the beaked whales, the latter of which are now represented in the gallery by a series of skulls.

Apart from a couple of porpoises, the models in the dolphin family include those of the killer and the white whale; the former species being remarkable for its bold alternation of light and dark colours, while the latter is unique on account of the pure creamy white hue of its glistening skin. Why the white whale should have a hide of this bridal hue, while its not very distant relation the pilot-whale (*Globicephalus*) is clad in deep sable, stands urgently in need of explanation. A model of the latter species is shortly to be added to the gallery; and, both on account of the spotted coloration of its skin and the peculiar conformation of the head, one of the narwhal would also prove an interesting addition to the series.

In the vestibule of the new gallery is a small case containing representatives of the small family of freshwater dolphins (*Platanistidæ*), the few living types of which are all creatures of comparatively small size. While the Indian susu (*Platanista*) is represented chiefly by skeletons and skulls, of the La Plata dolphin (*Pontoporia*) the plaster model of a specimen killed during my first visit to Argentina forms an attractive exhibit. Its peculiar light brown colour seems to have been produced to harmonize with the clear, but brown-stained waters of the River Plate.

Till the new gallery was opened the Cetacean collection of the Museum was exhibited in a low, ill-lighted, and crowded gallery, where the incautious visitor was only too likely to run the risk of cracking his own skull against that of a whale, and where skeletons alone formed by far the greater portion of the show. That gallery is now closed to the public, but the contrast between its dismal array of bones—almost unmeaning to all save the anatomist—and the present light and interesting exhibition will probably survive in the memory of some of my readers. In a word, while the old style was exactly what a museum ought not to be, the modern one is precisely what it should be.

REPETITION AND EVOLUTION IN BIRD-SONG.

By CHARLES A. WITCHELL.

THROUGHOUT the animal world we may find numberless instances of acts being rapidly repeated, with apparently only one sustained effort for the series, which acts seem to have originally been performed much less speedily and with separate efforts. Repetition means facility. Facility generally implies rapidity of repetition, and a series of acts for one purpose.

In the cries and songs of birds, we not only find indications of a former progressive evolution through the medium of mere repetition, but we may observe this evolution in actual development. I have elsewhere suggested that some prolonged alarms and songs of birds may be considered to have been evolved from mere repetitions of one cry. We may suppose that in some species a long song was a desideratum, since it is unaccompanied by any considerable variation in pitch. In the night-jar and grasshopper warbler there is practically no variation, though the latter "drums" in about the interval of a minor third.

The cricket-like chirp of the chiff-chaff may be heard everywhere, and is occasionally given in autumn as well as in spring; but I have never heard it rendered in more than three syllables; and it almost invariably consists of two only. It would be interesting to know whether readers of KNOWLEDGE have ever heard this uttered with four or five syllables. If such a local variation were discovered it might be considered as a survival of an earlier form of cry, or as an advance upon the ordinary song. I incline to the former proposition.

The turtle dove has a tremulous purring note, reminding one of the croak of the common frog (not of the more commonly heard "work, work" of the toad). It seems to consist of a very rapid succession of little coos. If greatly prolonged it would remind one of the note of the night-jar. In the common pigeon, and some of the doves also, a succession of little coos constitutes the whole song, which is often somewhat elaborate—as in the common collared turtle dove.

There may, of course, be the change of retrogression or reversal, as well as changes due to elaboration. The great titmouse seems to afford an instance of the former. The young (out of the nest) have a repeated cry with a curious wryneck-like tone, which may be rendered "klee, klee, klee." It is generally repeated from three to five times. The old bird never repeats a cry of this tone, but it utters a long single note as a cry of distress when a hawk is in sight. The cry of the young is no doubt inherited, and it may seem that the note may formerly have been repeated often by adult birds where it is now given only in single long cries.

On the other hand, the adult great tit has an alarm (a rapid "shashashasha") which is absent from the young. This is the most frequent danger signal of the old birds, and it always contains many syllables, all given, however, at the same pitch. How long it takes a wild titmouse to develop a variation of an alarm cry I know not, but in Western Canada I heard the marsh tits giving precisely the same note as their British prototypes, though the birds of the two countries must have been wholly separated during an incalculable period of time.

At Montreal, also, the house-sparrows (which were said to have been introduced fifteen years earlier from the States and not from England), had exactly the same cry, as well as the same manners, as the British bird. The sparrow, when bred in a cage, proves itself to have a strong tendency towards mimicry; yet these Canadian birds, like the marsh tits in the Far West, and the sparrows that chirp on the Bank of England, retained the ancestral tones of their species.

An interesting instance of repetition, developed in one strain to completeness, and in another not advanced beyond an elementary stage, occurs in the wood-wren. This bird's song consists of the simple repetition of a not musical sound, slow at first, but gradually getting faster until the song ends in an ecstasy. The whole may be rendered "si-si-si-sisisisisi." The pitch varies only a little; but there is a beautifully even *accelerando* in the strain. The bird has another cry which might be taken for a song, but this seems to be really a signal of danger. It is a full brief whistle repeated two or three times at the same pitch, and at about the rate of two per second. It may be written "kew, kew, kew." I have listened, but in vain, for any sign that even one of these birds had any inclination to repeat this beautiful note more than four times in succession. If that sound were somewhat prolonged, and given a few more times, it would rival some of the sweetest strains of the nightingale. But the wood-wren neglects this pure tone, and throws all his effort into the sibilous strain which falls to us from the tree tops, even as it fell on the ear of Gilbert White long ago.

The cuckoo, like the wood-wren, has developed the repetition of a note into a strain—a full-toned bubbling cry which is uttered at least by the female—yet the well-

known "cuckoo" is given with apparently no suggestion of a further development than the doubling of the first note.

The sedge warbler is much more inventive, for he frequently creates an original strain by associating two or three cries of other species, and repeating them in a certain order and with a definite accent many times successively in one song, thus proving what a single bird *can* do by means of repetition, and indicating what *may* be occurring much less quickly in other species.

In the thrush a few notes, often borrowed, are very generally repeated a few times, but never prolonged, as in the song of the sedge-warbler. The thrush, indeed, seems to repeat from lack of originality, and yet without sufficient persistence to produce striking strains.

The nightingale is, however, the master of repetition in song. The majority of his strains simply consist of one or two notes repeated with varying speed, the whole song including from two or three to twenty-five or thirty repetitions of one note. I have counted as many as thirty-three repetitions, given at about the rate of five per second, and this number is probably often exceeded, though not after the middle of May, when the song begins to wane. The charm of the bird may be partly due to its repetitions, for the ear is not so tired by them as by the rapid jerky songs of the blackcap, and some other quick singers, but may dwell on and enjoy each simple pure tone. The nightingale has acquired a magnificent *crescendo;* and one cannot but surmise that human ideas of this grace in singing may have been borrowed from the bird. The sedge-warbler and blackcap, and perhaps the wood-wren also, have imperfectly acquired it.

The origin of some of the nightingale's strains may presumably be found in single cries—a history which, in the case of the well-known long notes of the bird, is occasionally traversed at the present time. A little call-note, "tewy," is sometimes produced several times in succession, each note more prolonged than the last, until the strain ends in the ordinary long notes in all their sweetness.

The origin of certain prolonged strains may also be indicated in the cries of young birds. The nightingale, for instance, has a harsh "sisisisisi" which is quite unlike its sweeter tones. The fledged young one, however, when being fed, utters a similar long rapid cry. The ordinary cry of the young is a croak similar to that of the parents.

The young greenfinch, ready to quit the nest, utters when being fed, a rattling cry so like the "dididitit" rattle in the song of the parent that the only point of distinction is that the parent gives the strain in several keys, and interrupts it with other cries. The actual rattle is identical with that of the young.

The young fledged nuthatch, when being fed, utters a quick repetition of an almost toneless cry, with the same general character, however, as the full, bubbling, song-rattle of the adult.

It would, therefore, seem that when some song birds are developing their strains by simple repetitions of cries, they may be less inventive than at first appears, and be merely returning to an infantile mode of expressing a want.

The following note may be of interest as indicating that a bird whose habitat is remote from the range of our nightingale has followed a similar method in developing a song. The British birds have a rather short strain consisting of three or four peeting notes given at the same pitch, and an ensuing full rattling sound at a lower pitch, the whole sounding something like a "pee pee pee boblobloble." This is given throughout the season of song, though it is one of the least noticeable of the usual strains. It is varied in length of repetition very slightly, but is rendered in any interval of pitch between a third and an octave. Three years ago in Vancouver City, I was much struck with the song of a common bush-warbler, a bird with the general appearance and manners of our hedgesparrow. The bird gave this strain of our nightingale perfectly, except that the leading notes seemed to be very slightly inflected.

The strain was in all other respects the strain of our nightingale, pure and simple. It seemed never to be modulated by the Canadian bird; and it was particularly noticeable as being almost the only bird-song to be heard. But so frequent was it that the canaries on the houses near vacant "lots" had all "caught" the song, and included it in their own strains, and so accurately, that often I should not have known which bird was singing had not the sound come from some lofty window and not from the low bushes. I doubt not but that many of the canaries in Vancouver still have this strain, and that any local observer who has noticed the song of the warbler could confirm my statement as to the canaries. Did the Canadian bird borrow it from our nightingale or *vice versâ*? Or did they, uninfluenced by each other, follow the same course in elaborating their strains from simple originals?

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—V.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S.

THERE are many contrivances for moving through water, but, few if any, are more handy than rowing. Independently of any boat or implement the human swimmer rows with his front legs, commonly called his hands and arms. Birds, beasts, fishes, insects, and crustaceans use various appendages for the same purpose, and many of them might with more or less propriety be called oar-footed. Among crabs the genus *Remipes* has monopolized the title in its Latin form. In a Greek dress it falls to the Podocópa, a division of the bivalved Ostracóda. But more suitably, in another Greek derivative, it has been bestowed upon that extensive branch of the Entomostraca, which are therefore known as the Copépoda. These oar-footed crustaceans, individually considered, are a feeble folk, but in the mass much worthy of respect. Unlike their little boxed-up brethren the Ostracóda, they cannot produce an interminable list of fossils, or claim an unbroken record of representation throughout the entire series of stratified rocks, to prove the antiquity of their lineage. In this kind of documentary evidence they are singularly deficient. But when regard is paid to their extensive distribution, resourcefulness, variety of structure, beauty of form and colouring, and their indirect usefulness to mankind, they are found to occupy no undistinguished place in the realm of existing life.

Of some of this order there are said to be thirty generations in three weeks. Such prolific accumulation may seem incredible, but it harmonizes with the fact, repeatedly recorded, of ships traversing miles of ocean coloured in broad bands by dense masses of these small creatures. Dr. G. S. Brady says, "There can be no manner of doubt that the sea, from the Equator to the Poles, supports everywhere a profusion of Entomostracan life, chiefly of the order Copépoda," and Sir John Murray, of the *Challenger* Expedition, declares that "Copépoda were rarely, if ever, absent from the tow-net gatherings when examined on board ship," although the profusion was too great to admit of more than a selection being preserved. Dr. Giesbrecht describes a sort of fine drizzling rain that may sometimes be seen close to the smooth surface of the Mediterranean. It is a shrimpy shower, not from above, but from below. There are swarms of certain Copépoda at the surface, and

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the vivacious animals springing out of the water and falling into it again produce the strange effect.

Now, albeit that these creatures are so incalculably numerous, they had to wait long before attracting scientific attention. In 1770 there was published at Copenhagen, by J. E. Gunner, Doctor and Professor of Divinity, and Bishop of Trondhjem, an account of "Some small, rare, and mostly new, Norwegian sea-animals." Among these was one to which Dr. Giesbrecht awards the distinction of being the first of the marine free-swimming Copépoda that was ever described and figured. It is no little credit to the bishop, under these circumstances, that not only is his species clearly recognizable, but his description of it is almost entirely free from error. It should not be forgotten that "Cuf's magnifying glass," with which he examined his specimens, was not precisely the same kind of instrument which microscopists have at command in the present day. The species is now known as *Calanus finmarchicus* (Gunner), and is sometimes spoken of as "whale-food." That Gunner includes it among rare animals could only have been in regard to its novelty, for he himself says, that "Off Hammerfest, in West Finmark, the sea was teeming everywhere with these minute animalcules, and that a good number could be caught by merely letting the sea-water flow into a bottle." So far from being really rare, it happens that this is one of the four cosmopolitan species, ranging from north to south, indifferent to heat and cold. There are some four hundred* other species of marine free-swimming Copépoda, of which a comparatively few brace themselves exclusively with frigid waters, the majority preferring their bath decidedly warm or at least with the chill off. To the hardiest of the hardy must those belong, which are capable not only of existing, but of shining in the difficult situation which Nordenskiöld has described. "Very singular," he says, "is the impression experienced in walking on a cold, dark, winter's day (with the temperature nearly at the freezing point of mercury) on snow from which on all sides shoot at every step sparkles so vivid that sometimes one is almost afraid of seeing one's boots and clothes catch fire." The sparkles referred to in this passage emanate from living, though not, under the circumstances, free-swimming Copépoda.

Without, however, tempting the perils of the sea, or tramping over Arctic ice, the student, live where he may, can rely on being able to obtain a fresh-water *Cyclops* from the nearest pond. Little as it may seem to resemble crab or cumacean, lobster or woodlouse of the Malacostraca, upon careful comparison the relationship will become apparent. Examine the series of appendages. Observe that the head, just as in the Amphipoda and Isopoda, is supplied with two pairs of antennæ and four pairs of mouth organs. These latter are commonly spoken of as mandibles, maxillæ, first maxillipeds, second maxillipeds; whereas in the Malacostraca we are accustomed to the succession of mandibles, first maxillæ, second maxillæ, maxillipeds. The difference in naming came about in this way. The celebrated naturalist, Professor Carl Claus, in tracing the transformations experienced by young Copépoda, found reason to believe that there was a loss of one pair of maxillæ, and, on the other hand, a severance of the outer and inner branches of the maxillipeds to constitute two distinct organs. Like the traditional origin of Eve from Adam, this supposed making of two out of one has not commended itself to all investigators. Dr. Giesbrecht and Dr. H. J. Hansen agree in denying its validity, and, as Nature generally prefers the beaten track, there is a presumption that they are right. It is in the hinder part of the body, rather than in the front, that the Copépoda differ from the Malacostraca. Following the mouth organs are five, or occasionally only four, pairs of limbs, attached to as many segments. The first four pairs almost always, and the fifth pair often, are two branched. Then comes the pleon, or tail-part, without appendages, but like the

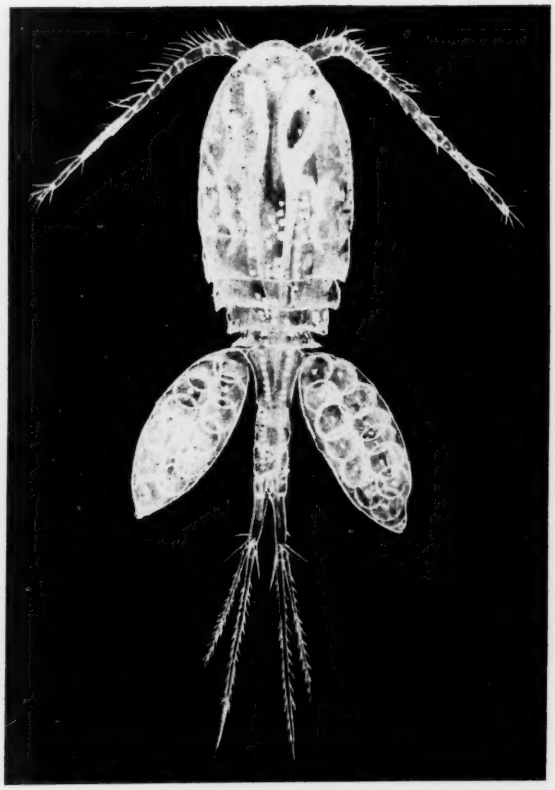

Figure of *Cyclops serrulatus* Fischer. From Uljanin.

trunk consisting of five segments (the first two usually coalescent in the female) and ending in the caudal fork with its apical setæ.

In one division, comprising the families Calanidæ and Pontellidæ, there is a well-marked separation between the trunk and the pleon. This division Giesbrecht calls the Gymnoplea, Copépoda with footless pleon, as opposed to the Podoplea, comprising the Cyclopidæ, Harpacticidæ, Peltidiidæ and Corycæidæ. The Podoplea, meaning Copépoda with foot-bearing pleon, have indeed a footless pleon, like all the Copépoda, but here the constriction between trunk and tail occurs after the fourth pair of limbs, and by that means the fifth pair of trunk-limbs, such as it is, often a very small affair, lends its support to the pleon, or tail-part of the animal.

The Gymnoplea generally have a pulsating heart, almost always lead a pelagic life, and have the joints of the appendages in general more numerous and more variously plumed than is the case in the Podoplea. The latter scarcely ever have a pulsating dorsal vessel, and include, besides numerous marine species, almost all that live in fresh water.

As these papers have the insidious object of tempting

* More than forty of these were added in one batch from the Gulf of Guinea, by T. Scott, Esq., F.L.S., in 1894. *See Trans. Linn. Soc., London*, Zool. Sec. 2, Vol. 6, Part 1.

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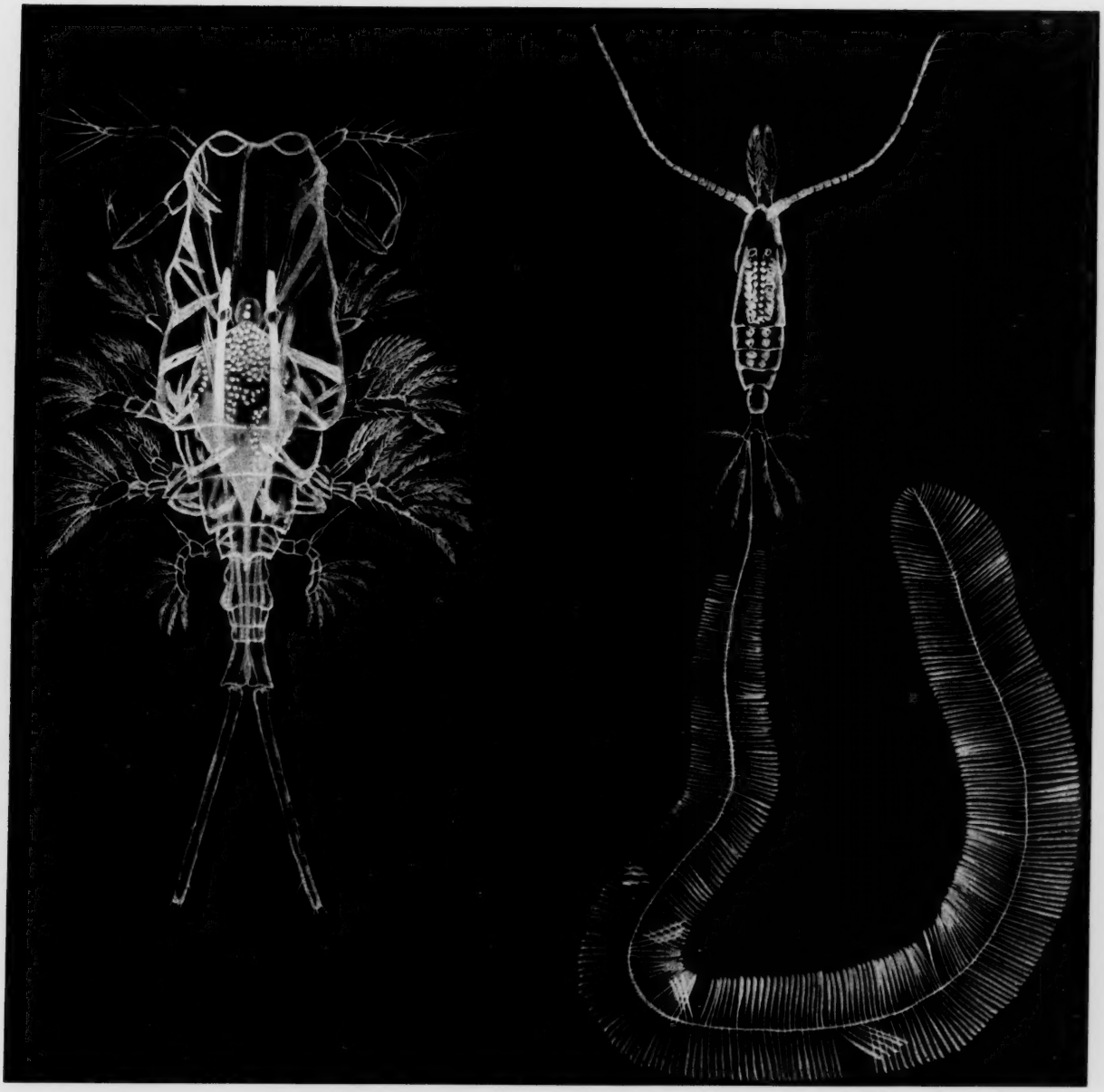

COPILIA VITREA (Haeckel).

From GIESBRECHT.

CALOCALANUS PLUMULOSUS (Claus).

From GIESBRECHT.

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the unwary reader to become a student, it would be wrong to linger any longer on the dry and endless details which belong to anatomy and classification. In the first chapter

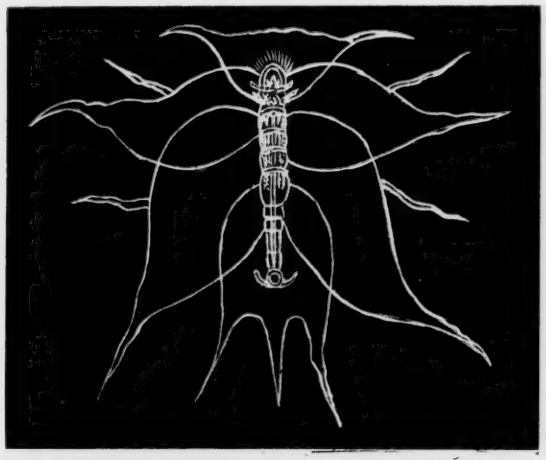

Figure of *Notopterophorus papilio* Hesse. From Brady.

mention was made of *Notopterophorus papilio*, to give a hint of the profundity of learning of which the subject was capable. The names of this truly remarkable Copepod species signify "a butterfly which carries wings on its back." Most butterflies have that privilege. But this is a crustacean, member of a class which climbs the mountain and fathoms the abyss, but which never made the least pretension to have wings to fly with. Yet this wonderful species indicates that Nature, if it chose, could even make a flying crab.

Dr. Giesbrecht's name has been more than once mentioned. To his monograph of the pelagic Copépoda (*Fauna und Flora des Golfes von Neapel*, Mon. 19, 1892) those should turn who are willing to be entrapped by the fascinations of this branch of study. On seeing some of these "off-scourings of the sea," as the eye of the microscope and the eye of the artist have combined to reveal them, it is probable that the most contemptuous will be surprised into admiration. Dried specimens, and specimens preserved in spirit, as they are seen in collections, are commonly reduced to a uniformly pallid tint, so that few persons know or ever behold the richness and variety, the gaiety and even splendour of colouring, of which these tiny denizens of the sea are susceptible. Crustaceans brought up from the gloomiest depths are frequently gorgeous in orange and crimson. Of Copépoda which frequent the surface many, as already explained, are either transparently hyaline, brilliantly iridescent, or variously decked with points or bars or splashes of brightly harmonious colours. Some of them have ornaments which, when magnified to suit our dulness of sight, appear quite astonishingly graceful. In this respect the genus *Calocalanus* seems to deserve the palm, and within this genus the species *Calocalanus pavo* (Dana) may be held to compete in beauty with the bird after which it is named, if our minds can be brought to tolerate a comparison between the haughty fowl which condescends to adorn our pleasure grounds and a little ocean waif with a body the twentieth part of an inch long. It is not easy to explain in words the quality of distinction and the charm with which the marine organism is really invested, although on a scale so infinitesimal. The body is slenderly oval and colourless. Through the pellucid segments of the back can be seen the mass of orange-coloured eggs, for it is the female which is the more exuberantly beautiful. In front, on either side of the head, are extended with gracious sinuosity the twenty-five jointed first antennæ, nearly twice as long as the body, which they help to keep steadily balanced in the water. The bristles of various shapes, sizes, colours, and functions, with which the several joints of these antennæ are adorned, are important in the animal's economy, as well as very conspicuous features in its array. They shoot out in all directions like a shower of rockets. But this remarkable apparatus becomes almost commonplace by comparison with that of the caudal extremity. Each branch of the furca has four bristles. Such caudal bristles may be simple, serrated, or plumose, but, in any case, they are usually narrow and tapering. Here, on the contrary, from a slender stem the feathering gradually widens till it equals the breadth of the animal's body, passing from limpid clearness at its base to a magnificent orange and brick red, with a metallic gleam, over all its broadly-rounded distal portion. When the animal is in repose, the furcal arms are extended at right angles to the body, and then all its brilliant feathers are spread abroad in dazzling symmetry, like the train of a Court lady wrought in satin of "old gold."

Another species of this same genus, *Calocalanus plumulosus* (Claus), though inferior in charm, is even more wonderful in appearance. Like its congener, it has four caudal bristles on each furcal branch. These are bright orange in hue, all of very moderate length and breadth, with one exception. The exception is the innermost on the left side. This attains a truly colossal magnitude, being nearly twice the width of the animal's body and about six times its length. The feathering extends over almost the whole of this singular and very fragile ornament, which, if regard be had only to proportions, may vie with any single plume that the most wonderful bird can boast of.

In some genera the brilliance of adornment is shown rather at the middle of the body than at its extremities. *Copilia vitrea* (Haeckel), by the glassiness which its name implies, permits a facile study of its internal anatomy, and accordingly it is able to exhibit attractions in a part of the organism from which a display of beauty is not usually expected. The stomach is a magnificent orange-red. On either side, its four pairs of swimming-feet make a gorgeous show by means of their conspicuous feathered bristles, not exactly gleaming with purple and gold, but tipped with violet, and in other parts lustrous with a hue that matches the unwonted splendour gleaming from within the body.

Apart from the beauty of the Copépoda, there are many points of interest, such as the strange forms developed for special purposes in the antennæ and fifth pair of limbs, the peculiar eyes of *Copilia* and *Corycæus*, the problems of distribution, and others which remind us that, within the compass of a few columns, nothing more is possible than a little fluttering over the surface of so vast a subject. The parasitic Copépoda may claim a chapter to themselves.

ECONOMIC BOTANY.

By JOHN R. JACKSON, A.L.S., etc., *Keeper of the Museums, Royal Gardens, Kew.*

MALVACEÆ.—This is a large and important economic order, marked by two distinct characters which pervade the plants constituting the order, namely, the fibrous inner barks and the mucilaginous or gummy substances found in the stems, roots, and fruits. None of the plants have any

deleterious properties. Their geographical range is wide, though they are most abundant within the Tropics. The forms of the plants included in the order vary considerably, from small herbs, as in the marsh mallow, to the baobab (*Adansonia digitata*), or the giant silk cotton trees (*Eriodendron anfractuosum*).

The order is divided into four groups or tribes. Malveæ, which includes the mallows and the species of *Sida* and *Abutilon*, well-known fibre plants of India and China. Ureneæ, of which the principal products are fibres furnished by species of *Urena*, *Malachra*, and *Malvariscus*. Hibisceæ, containing the several species of *Hibiscus*, *Gossypium*, and *Thespesia*; and Bombaceæ, which includes *Adansonia*, *Bombax*, *Eriodendron*, and others.

The following are the most important species of *Hibiscus* from an economic point of view:—*H. esculentus*. This is a large annual herb growing to a height of five or six feet, the native country of which is uncertain, though opinion inclines to some part of Africa. At the present time it is cultivated all over the tropical and warmer parts of the world, chiefly for the sake of the mucilaginous fruits which are known under the various names of okro, gombo, or bendikai. These fruits are narrowly oblong or fusiform, from three to ten inches long, and dehiscing, when ripe, by longitudinal sutures. In the young green state the fruits are extensively used as an article of food, particularly for the purpose of thickening soups. In the very young state they are sometimes pickled like capers. The seeds contain oil of good quality, and is expressed in some countries and used for culinary purposes. They are also roasted and used as a substitute for coffee. The fibre from the stem is used for ropes and cordage. Another annual largely cultivated in India, Ceylon, and in other tropical countries is the roselle (*Hibiscus sabdariffa*). This is grown both for the fibre, used like the last-named, and for the fleshy calyces of the fruit, which are of a reddish colour when fresh, and are made into a kind of preserve. Other species of *Hibiscus* yielding fibres of equal quality are *H. cannabinus*, *H. abelmoschus*, and *H. elatus*. The first named is an Indian species, while the two latter are West Indian. *H. abelmoschus* is known as the musk mallow, in consequence of its seeds possessing a strong, musky odour, for which reason they are frequently used in perfumery as a substitute for animal musk. *H. elatus* is the tree from which Cuba bast is procured, a substance better known twenty years ago than at the present time. It consists of the inner bark of the tree, and was at one time largely used in gardens for tying up plants as well as for tying bundles of Havanna cigars. In gardens, however, it has long been superseded by raffia, and in the Cuban cigar trade by ribbon. Even now Cuba bast occasionally finds a use in this country, and not long since it was adopted, after bleaching or dyeing, for the manufacture of ladies' hats in consequence of its lightness and lace-like appearance.

By far the most important plants in the whole family of Malvaceæ are those species of *Gossypium* which furnish cotton of commerce, the chief of which is *G. barbadense*, a large herbaceous or shrubby plant growing to a height of nine or ten feet, with numerous widely-spreading branches, and bearing capsular fruits dehiscing into three or five valves, and containing numerous closely-packed seeds entirely buried in a mass of long, very delicate white hairs, varying in length from a quarter to an inch or more. The commercial value of cotton is judged by the length and strength of the fibres, or staple, as it is termed in trade, and the clean separation of them from the seeds, and it is these two essential qualities that cause the cotton produced by *G. barbadense* to be of a much superior quality to that produced by other species, or indeed by some varieties of the same species. The separation of the fibre from the seed is so marked in the different qualities that in the Sea Island cotton of commerce the mass of fibres can be readily removed from the seed by the fingers without breaking the fibres and leaving the seed perfectly clean, while in others, and inferior qualities, the fibres break away, leaving the seeds thickly clothed with the woolly bases. *G. barbadense* is supposed to be a native of the West Indies, as its specific name would imply. Its culture at the present time is spread over a large portion of the warmer regions of the globe, and, as is commonly the case with plants so long and widely cultivated, it has numerous varieties, known in commerce under distinct names, such as Sea Island, Kidney, Peruvian, Bahia, Brazil, and others. These varieties are cultivated in the West Indies, the Southern United States, Central and South America, and other countries. *G. herbaceum* and *G. arboreum* also furnish some of the cotton of commerce.

In a brief *résumé* of the economic plants of the several natural orders like the present it is impossible to detail the processes employed in the preparation of cotton for the market; or even to speak of the numerous uses to which this most important product is put, but as a proof of the value of a single vegetable fibre we may quote the following returns of the imports and value of raw cotton into the United Kingdom during the year 1897:—

	Cwts.		£
From United States ...	12,323,090	value	24,557,513
„ Brazil	150,129	„	303,425
„ Egypt	2,447,616	„	6,484,450
„ British India ...	375,777	„	636,267
„ Other Countries	97,522	„	213,077
Totals ...	15,394,234		32,194,732

Besides the fibre another useful product is the seeds, which at one time were considered of no value, and were used as manure for the land; for some time past, however, they have been largely used for the expression of oil, which has been applied for illuminating purposes, oiling machines, and in the preparation of woollen cloth and morocco leather, also for soap making, and, when highly purified, for mixing with olive or almond oils, or as substitutes for them. After the expression of the oil the cake is much used for feeding cattle.

The baobab, or monkey bread-tree (*Adansonia digitata*), which belongs to the tribe Bombaceæ, is a tree of considerable interest, if not of high value, from an economic point of view. It is a native of west tropical Africa, but is found cultivated in many parts of India and Ceylon. It grows to a height of forty to sixty feet, with a diameter of trunk of thirty feet, and attains a great age. Humboldt speaks of it as "the oldest organic monument of our planet." The trunk is covered with a very thick fibrous bark, from which the natives make ropes and nets. It has been proposed as a material for paper making, and paper of good quality has been made from it; but as the supply must necessarily always be limited, its future as a paper material is very doubtful. On the other hand, where the quantity required would be less—such, for instance, as the plaiting for ladies' hats—it might, and indeed has been found an useful article, for a few years ago it was so used, after being bleached or dyed in various colours. The remarkably large fruit of the baobab (often two feet long and one foot diameter in the middle) contains a quantity of pulp which is of an agreeable acid taste, and is used by the people for making a refreshing cooling drink, besides which the fruits are used as floats for fishing nets. *Bombax malabaricum*, a large soft-wooded Indian tree, has a coarse fibrous bark, from which rough ropes are made in India.

The seeds are buried in silky floss, generally known as silk cotton, which, however, has little or no strength, and is not capable of being spun into fabrics. Another kind of silk cotton of very similar character is obtained from the capsules of *Eriodendron anfractuosum*, also a large, soft-wooded tree, native of the tropics of the old and new worlds. Under the name of "Kapok" this substance has been exported from Java to various parts of Europe for many years past in large and increasing quantities, for the purpose of stuffing mattresses, cushions, &c. Like the silk cotton of *Bombax*, it is quite unsuited for spinning. One of the most remarkable edible fruits of Malacca and the Malay Islands is that known as the durian, the produce of *Durio Zibethinus*. It is a large globular fruit, dehiscing when ripe, and covered with strong spines or prickles. The pulp is described by those who have become accustomed to it as one of the most delicious of tropical plants, but by those tasting it for the first time it is said to have a flavour of civet, turpentine, and garlic.

STERCULIACEÆ.—The plants constituting this order are trees and shrubs, mostly of tropical countries. The woody stems, though soft, are for the most part stronger and somewhat harder than those of the silk cotton group, to the properties of which, in many respects, they are similar. Thus, the inner barks are mostly fibrous, and ropes and cordage are made from them in the countries where the plants grow. More particularly is this the case in the species of *Sterculia* itself; in three of the best known Indian species, namely, *Sterculia urens*, *S. villosa* and *S. fœtida*, the barks are used for cordage. The sterculias also yield a quantity of gum of a light colour, very much resembling, both in appearance and in their properties, gum tragacanth, inasmuch as they absorb a quantity of water, and swell before dissolving. The sterculia gums are much used in India as substitutes for tragacanth, and are known as Kuteera. Similar gums are produced in tropical Africa, as well as in Australia from allied species of *Sterculia*.

The Kola Nut, which in a comparatively few years has established itself as a regular and an important article of trade, is the seed of *Cola acuminato*, a tree of about forty feet high, native of the West Coast of Africa. Amongst the natives the kola nut has been long used as a remedy for satisfying the cravings of hunger, and enabling those who have to endure great fatigue to do without actual food for a long period. During the last twenty years kola has attracted considerable attention in this country, and the plants have been introduced into most of the British Colonies possessing a suitable climate for its success, and in the West Indies it has become quite established. Kola contains a large proportion of caffeine, and is much used in the preparation of certain kinds of cocoa, as well as for other purposes.

Another very important plant in the order is the cocoa (*Theobroma cacao*), a moderate-sized tree, a native of Brazil and other northern parts of South America, extending into Central America and Mexico. Under cultivation the tree is found in the tropics of both hemispheres, but especially in Trinidad, Venezuela, New Grenada, Jamaica, and more recently in Ceylon. As might be expected with a plant so long and extensively cultivated, a large number of varieties are known, distinguished by the size, shape, and colour of the fruits and the quality of the seeds. For the preparation of the seeds for the market they are first removed from the pulp of the fruit in which they are embedded, washed and slightly fermented, and when dry are ready for the market. For the preparation of cocoa and chocolate they are slightly washed and the outer husk removed, when they readily break up into small, irregular pieces, and in this state are known as cocoa nibs—the only state, indeed, in which they were known in Europe forty or fifty years ago. To prepare the soluble cocoas of the shops they are ground into a fine powder, and often mixed with starch, sugar, and other ingredients. Chocolate consists of the same seeds very carefully pounded or ground in powerful mills, and sweetened and flavoured with vanilla and various other spices. In the preparation of pure cocoa nothing, of course, but the seed is used, and a certain proportion of the oil, or natural fat, which is contained in the seed, is first extracted and forms what is known as cocoa butter. The seed contains about half its weight of oil. This cocoa butter is much used in pharmacy for suppositories, as well as an ingredient in ointments and for coating pills for all purposes, for which it is strongly recommended on account of its agreeable bland taste and freedom from rancidity. The uses of cocoa and chocolate in this country have greatly increased of late years, the quantity of raw cocoa entered for home consumption last year amounted to twenty-seven millions, eight hundred and fifty-two thousand, one hundred and fifty-two pounds against twenty-four millions, five hundred and twenty-three thousand, four hundred and twenty-eight pounds in 1896.

TILIACEÆ.—An order of trees and shrubs, and very rarely herbs, the species of which are most abundant within the tropics, though some are natives of the more temperate regions of both hemispheres. The trees are noted for their even and close grained, yet soft and easily cut wood, which is well represented in the common lime (*Tilia europea*) and the American bass wood (*T. americana*). The durability of the wood of the former and its adaptability for carving is further exemplified in the lime wood carvings by Grinling Gibbons in Hampton Court Palace, St. Paul's Cathedral, and other public buildings. Another character of the tiliaceæ is the fibrous barks found in most of the species, notably in the lime tree, which forms Russian bast from which mats are made, used for covering plants, and by upholsterers for packing furniture. From the fibrous point of view, however, by far the most important plant in the whole order is that furnishing jute (*Corchorus capsularis*). It is an Indian plant, cultivated to a large extent in Bengal for the sake of the fibre which is contained in the inner bark. For the purpose of increasing the length of the fibre the seeds are sown thickly to cause the plants to run up without branching. The stems, which seldom exceed in thickness that of the finger, are steeped to soften the fibrous bark, which is afterwards removed and the fibres combed out and cleaned. The rapid development of the trade in this fibre is remarkable; fifty years ago it was scarcely known out of India, where it was, and is still used for making rice and sugar bags. In 1846 the imports of the fibre to this country amounted to about nine thousand tons, which in 1897 had increased to three hundred and thirty-six thousand, nine hundred and nineteen tons. Jute fibre is now used for various purposes, such as carpets, tapestries for curtains, sacking, twines, and even for adulterating cheap silks.

LINEÆ.—This is a small order of trees, shrubs, and annuals well known for their bright but fugitive flowers. Many of them, like the plants in the last-named order, are marked by the presence of a fibrous bark, the most important being the common flax (*Linum usitatissimum*), a stiff-growing slender stemmed annual, the native country of which is not known, the cultivation of the plant dating from the remotest periods of history. It readily escapes from cultivation, and is found in a half-wild state in almost every country where it is grown. Its cultivation at the present time is widely extended in both temperate and

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tropical climates, as, for instance, in Russia, Egypt, India, Holland, England, and the United States. Enormous quantities of linseed are imported from Russia and India.

In this country the flax culture has been declining for many years, though English-grown linseed is usually considered the best quality. The principal constituents of linseed is a fixed oil, which it contains to the extent of one-third of its weight, and a quantity of mucilage which is contained in the testa. The oil is expressed and forms the well-known linseed oil of commerce, so largely used for mixing with paints, as well as for various other purposes, and the mucilage causes the seeds to be valuable in the preparation of linseed tea—a well-known demulcent drink used in inflammatory conditions of the mucous membrane. The imports of linseed during the year 1897 amounted to one million, nine hundred and eight thousand, six hundred and twenty-eight quarters, the value of which was two million, nine hundred and eighty-eight thousand, five hundred and three pounds. Though this is a considerable sum derived from one species of plant, it is not the largest item in the total value of the flax plant, for besides linseed, the flax fibre obtained from the stem shows a still greater money value; for during the same year, 1897, flax in its various stages of preparation was imported to the extent of ninety-eight thousand, eight hundred and two tons, of the value of three millions, two hundred and three thousand, one hundred and eighty-four pounds. Flax is so well known that it is unnecessary to say more of it than that it is the cleaned fibre of this slender-stemmed plant, the value of which as a textile has been known from the very earliest periods, and continues to the present day, for it is the strongest and best vegetable fibre known capable of adaptation for the finest fabrics, as delicate muslins, and the coarsest, as tarpaulins, and, notwithstanding the introduction and adaptation of numerous vegetable fibres in recent years, flax still maintains its superiority.

Another important plant of the Linaceæ which has come much to the fore in recent years is *Erythroxylon Coca*, from the leaves of which is prepared the well-known *Cocaine* of the medical profession. The plant is a small shrub, two to four feet high, cultivated to a very large extent in the Andes of Peru, and in Bolivia and Columbia, also in parts of Brazil, Argentina, etc. It is considered to be a native of some of these countries, though it is unknown in an actual wild state. It has long been in use by the natives, who chew the leaves with a little unslaked lime for the purpose of lessening the desire for food, and enabling the chewer to undergo a large amount of bodily exertion without fatigue. For this reason it is a common practice to carry the coca leaves about with them, together with a small gourd for holding the lime. In gathering the leaves much care is exercised by the people so as to ensure their absolute dryness, and not to break them. In Peru, the plants begin to yield the first crop of leaves in three years after planting, and in some favoured localities two or three crops are obtained in one year. The largest and most mature leaves are said to contain the largest amount of cocaine. The leaves have an agreeable and somewhat aromatic smell. Cocaine is now very largely used as a local anæsthetic, and in the preparation of coca wine. Under cultivation, several variations from the specific type have arisen.

THE announcement of the retirement of Sir William Flower from the Directorship of the Natural History Museum at South Kensington was received with great regret. We learn that Prof. E. Ray Lankester has been appointed to succeed Sir William Flower.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

LATE ARRIVAL OF SPRING MIGRANTS NEAR EXETER.—The current year has, so far, proved a most uninteresting one from an ornithological point of view in this neighbourhood. It has been distinguished by the great scarcity of most of our summer migrants, and the very late appearance of some of them. Although daily on the look-out for Chiffchaffs and Willow Warblers, I did not see any till the 7th June, when Blackcaps, Willow Warblers, Chiff-chaffs, Garden Warblers and Spotted Flycatchers all suddenly appeared here, and were seen for a few days. Since then I have noticed very few of them. No Blackcaps visited the ripe berries of the ivy in April, as usual, and very few have frequented the currant bushes. Whitethroats were first seen on June 8th and 9th. Redstarts did not show until June 15th, but at the end of the month they were numerous at Chagford. Only one Sedge Warbler has been seen amongst the reeds here, and that was on the 10th of June. Common Sandpipers were first seen on April 15th, when two were on the river, and many on 21st of the month. At the end of June, I saw a great many on Dartmoor about the upper part of the North Teign, where they nest. The first return from the breeding grounds was on July 29th. The Cuckoo was heard on the 14th and 19th April, and afterwards became very numerous. Swallows have been scarce. The first was reported from the north of the county, near Barnstaple, about the 10th April, but I saw none until the 21st of the month, when I observed some in the streets of Topsham. A few Sand Martins were seen flying over the Exe on April 25th. Although the Rev. M. A. Mathew observed a House Martin at Buckland Dinham, in Somersetshire, on April 26th, I failed to see any here until June 19th, and there were very few at Chagford (where this species is usually very numerous) at the end of the month. It is certainly much less abundant in South Devon than it has been in most years. I noticed two Swifts on May 2nd, apparently coming from the north-east, but there were very few about until the 20th of the month, when numbers arrived from a southerly direction. On June the 9th Mr. Mathew saw four Turtle Doves on the foreshore of the Exe estuary below Lympstone. None now visit our marsh, where a small flock used formerly to feed, in July and August, on the seeds of the plants growing on the salt mud. We also saw a Red-backed Shrike near Budleigh Salterton. I imagine that the cold at the end of March and beginning of April, and the prevalence of cold blustering westerly winds at the migration time, prevented the arrival of our spring migrants by the ordinary route across the Channel, and those that reached us probably mostly came across England from the East. Hence they were noticed earlier in Somersetshire than about Exeter. —W. S. M. D'URBAN, Newport House, near Exeter.

LESSER BLACK-BACKED GULLS ON THE EXE.—On April 13th I watched a small flock of Lesser Black-backed Gulls resting on the shingle outside our lawn wall at low water. They were mostly immature birds of last year, but there were a few adults among them. This gull is by no means common on the Exe, and this is the first time I have ever observed a flock of this species on the river.—W. S. M. D'URBAN.

PEREGRINES AND HERRING GULLS.—On March 12th, while watching the Peregrine Falcons at Beachy Head, I was surprised to see these birds chased by Herring Gulls; yet immediately afterwards I found the body of a Herring Gull which had evidently been struck down by a Peregrine.—C. J. WILSON, 21, Earlsfield Road, S.W.

On a Hybrid Thrush found in Norway (*Turdus iliacus* × *Turdus pilaris*). By R. Collett (*Ibis*, July, 1898, pp. 317-319).—Prof. Collett here describes a specimen of a bird which he believes to be a hybrid between a Redwing and a Fieldfare. The bird was snared in Faaberg, Norway, on December 11th, 1897, together with some examples of the Fieldfare. Prof. Collett diagnoses the specimen as follows:—"Size, halfway between those of *T. pilaris* and *T. iliacus*; eye-stripe broad, of a buffy white; upper parts most like those of *T. pilaris*; rump, greyish brown, somewhat lighter than the back. Lower parts most like those of *T. iliacus*; the side spots somewhat triangular; under wing-coverts, rusty red mixed with pale red." A similar specimen was caught near Stockholm on February 12th, 1859, and is still preserved in the Riks Museum, Stockholm.

Iceland Gull in County Sligo in Summer (*Irish Naturalist*, August, 1898, p. 200).—Mr. Robert Warren observed a bird of this species on July 18th feeding in company with some Herring Gulls in a field. At about a distance of ten yards, and with the aid of field glasses, Mr. Warren made the bird out to be an immature one. This is only the second time the Iceland Gull has been observed in Ireland in summer.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE "QUAGGA."

To the Editors of KNOWLEDGE.

SIRS,—In your May number, on page 138, Mr. R. Lydekker calls the quagga an extinct animal. He says: Zebras "and the now extinct quagga." He is mistaken. At the moment of writing, the skin of a quagga is in the backyard being salted and preserved. The quagga was shot one month ago between Zwazieland and the Portuguese territory from a troop of four. Signs of larger troops were seen then and there. Hunters report still larger herds more to the north.

H. W. M. LAGERWEY, LL.D.

Johannesburg, June 29th, 1898.

[In reference to the above, it is a well-known fact that the name "quagga" is now commonly applied in South Africa to Burchell's zebra (*Equus burchelli*), although it properly belongs to the apparently extinct *E. quagga*, which is a very different animal.—R. L.]

PHOTOGRAPHING THROUGH A FLY'S EYE.

To the Editors of KNOWLEDGE.

SIRS,—If any readers of KNOWLEDGE wish to try Mr. F. W. Saxby's interesting experiment, but are unable to get "eye-lenses" (and dragon flies do not flourish in towns), I have a good number of the cast nymph skins of the dragon fly, *Anax formosus*, which I will very gladly send to anyone who cares to send an address. The cornea is facetted, hyaline, and, moreover, has the advantage of being already almost perfectly clear. ARTHUR EAST.

Southleigh Vicarage, Witney, Oxon.

U ORIONIS AND S AND U CORONÆ.

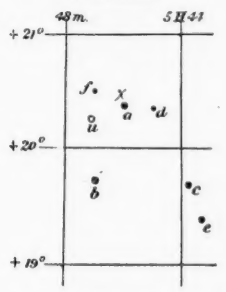
To the Editors of KNOWLEDGE.

SIRS,—A maximum of U Orionis was computed for March 28th, 1898. It is an interesting star, and the past apparition increased the desire to know more about it. Being near the zenith most of the time, the opportunities were more favourable for its observation than for other stars.

It appeared to be on February 11th at about ninth magnitude, and from that day forward as follows:—

Feb.	22	... ...	7·8	Feb.	28 ... ... 7·3
,,	24	... ...	7·6	Mar.	2, 4, 5 ... 7·2
,,	27	... ...	7·4	,,	8 ... ... 6·8
				,,	13, 15, 16 6·5
				,,	19 ... ... 5·9
				,,	20 (max.) 5·9
				,,	24 ... ... 6·1
				,,	26 ... ... 6·3
				,,	31 ... ... 6·4
				April	1, 2 ... ... 6·5
				,,	6, 7, 9 ... 6·6
				,,	14, 16, 19 6·8
				,,	24 ... ... 7·1
				,,	26 ... ... 6·7
				,,	27 ... ... 6·8
				,,	28 ... ... 6·7
				,,	28, 29 ... 6·6
				May	1 ... ... 6·8
				,,	7 ... ... 7·15

U Orionis.



D.M.	19° 1106	6·8	mag.	*e.*
	,, 1110	6·00	,,	*c.*
	,, 1126	6·30	,,	*b.*
	,, 1156	7·20	,,	*d.*
	,, 1162	5·00	,,	*a.*
		7·90	,,	*f.*

Lost behind trees.

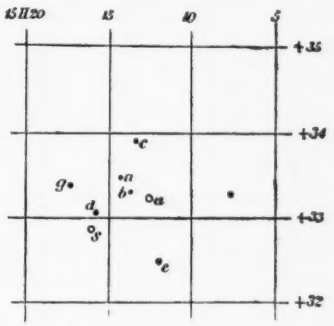
Except on a few nights the seeing was unsteady, and the light-curve irregular.

Comparisons were made with the D.M. stars in the field or close by.

When S Coronæ rose clear of the eastern city vapour and smoke on March 13th it seemed to be at its brightest, 6·7 magnitude; this apparition was four days after the computed maximum, and, as usual, it remained on a level until the middle of the following month. The first and subsequent changes were noted as follows:—

April	14 ...	6·8	
,,	15 ...	6·9	
,,	16 ...	6·8	
,,	19, 24	6·9	
,,	25, 26	7·0	
,,	27, 28	7·1	
,,	30 ...	7·2	
May	8 ...	7·5	
,,	10 ...	7·4	
,,	11, 15	7·7	
,,	17 ...	7·8	
,,	19 ...	7·9	
,,	22 ...	8·1	

S and U Coronæ.



D.M.	31° 2719	7·0	mag.	*e.*
	,, 2724	7·3	,,	*d.*
	32° 2561	6·5	,,	*f.*
	,, 2569	U var.		
	,, 2577	7·8	,,	*g.*
	33° 2572	9·0	,,	*b.*
	,, 2573	8·9	,,	*a.*
	,, 2574	6·8	,,	*c.*

Comparisons were made with the D.M. stars in the field

and close by. The star was regular in its movements, but the seeing was only occasionally good. The maximum, which evidently was a bright one, seems to have been passed on or about the computed date for that phase, March 8th. DAVID FLANERY.

Memphis, Tenn., U.S.A.,
23rd May, 1898.

A THEORY OF REFRACTION IN SUN-SPOTS.

To the Editors of KNOWLEDGE.

SIRS,—I do not find that Mr. Jenkinson's objection, that the refraction (illustrated in the August number of KNOWLEDGE) would be destroyed by a blast from a pair of bellows, has any foundation in fact. I enclose a photograph which will show that a current of air has but little effect on the refracted bottom.

I have intentionally removed the "penny," as this has but little to do with the discussion.

It is, of course, true that a very slight ripple will often destroy refraction, but this is from a cause that we can hardly expect to find reproduced on the solar surface. In rippled water the refraction is often destroyed by the reflection of the sky or of bright objects; but if the surface be shielded from bright *reflections*, refraction will suffer but little. ARTHUR EAST.

Science Notes.

The report of the Select Committee on Museums of the Science and Art Department has furnished abundance of material for those who make it their business to criticise the responsible agents of our State-aided institutions. "The South Kensington Ring," the "Brompton Boilers," the "Poor Relations' Benevolent Institution," and such like sly insinuations have for many years been the only encouragement which the heads of departments at South Kensington have received from some quarters. "The work has in innumerable instances," says one of our contemporaries, "been bad to the extent of dishonesty, and a gross waste of public money. Indeed, so extravagant are the faults proved against the department, that one can hardly credit the truth of them." Even if all this be true, the fact remains that the Department has accomplished an incalculable amount of useful work, the mature fruit of which still remains to be gathered in.

A number of the cases of birds and their nests at the Natural History Museum have been photographed by Messrs. Newton & Co., and a series of coloured lantern slides have thus been produced. Stuffed birds usually look stiff and unnatural in a photograph, but the natural surroundings in the cases photograph well, and the slides are on the whole accurately coloured.

Mental fatigue—the most characteristic of the ills that flesh, or at all events civilised flesh, is heir to—has during recent years been made the subject of careful scientific observation. Though there is still much to be learnt respecting the factors influencing it, a very great deal has been added to our knowledge of the conditions attending its occurrence, and the means necessary for its dissipation. The investigations regarding mental fatigue naturally fall into two divisions. There is, first, the effect of intellectual effort upon the physiological activities of the body; and, second, the result upon the mental powers themselves. It has been fairly proved that all intellectual work has an immediate effect upon the physiological state of the various bodily organs. Thus, the earliest result of the mind's activity is to quicken the heart beat, though after half-an-hour a distinct slackening follows. This is naturally accompanied by an increased blood pressure on the brain. Similarly, respiration is quickened, though the inspirations and expirations of air are not, individually, as vigorous. The amount of tissue used up in the body increases, too, as is shown by the larger absorption of oxygen from the air, and the increased expiration of waste product in the form of carbon dioxide. Such increased wasting away of the material of the body has been found, as one would have expected, to carry with it an increase in bodily temperature. A particularly important relation has been made out between intellectual and muscular effort. While a brief mental exercise of fifteen minutes or less seems to increase the momentarily available muscular energy, a longer mental exertion distinctly decreases it, though when it is accompanied by emotional excitement this mind work may not be followed by the enfeebling of the muscles until much later. Observations made in a French school show that the amount of bread consumed by the pupils, who were always allowed to have just as much as they wanted, decreased with fair regularity until the minimum was reached in July. This is interpreted to mean that there is a gradual decrease in vitality as the result of continued school work. Many other results of less popular interest have been obtained and will be found described in an excellent volume on mental fatigue, by Professors Binet and Henri, recently published in Paris.

Many people believe that soon after death a peculiar smell arises from the body. "There is death in the house," old women will say. So, too, it is well known that in some countries ravens appear, oftentimes in large numbers, almost immediately animals have expired. It is easy to explain all such phenomena by changes due to decay of the body; but the smell before death, which is referred to as *odor mortis*, is not so easily understood. This "death smell" attracts several species of flies to the dying in certain seasons, and the approach of death in a human being or animal, if it occurs at a time of the year when these insects are in active life, is said by some to be unmistakably heralded by the determined manner in which such flies settle on the skin, especially in the region of the nostrils. According to many authorities the smell is unappreciable to average nasal organs, though not a few trained observers are without doubt of its existence. Of numerous cases which have recently been put on record in the *British Medical Journal*, one or two may be referred to here, as they provide sufficient ground for further investigation. An apparently strong, healthy nurse was suffering from a severe attack of typhoid, and towards the end of the first week a peculiarly heavy odour was noticed about the patient by the doctor in attendance, and since he had noticed a similar smell in previous fatal cases he felt anxious. Shortly after the odour had been detected the nurse developed other symptoms and died. Another physician records that having remarked the smell in the case of a child, who otherwise did not appear to be seriously ill, he regarded it as a sign of most unfavourable import, and sought a consultation. The consultant thought there was no cause for anxiety, yet the child died within forty-eight hours. These, and other cases described by medical men, certainly give ground for the belief that, in some cases at least, the approach of death is heralded by a strange odour, though it is difficult to understand exactly the cause of its occurrence.

VARIABLE STARS OF SHORT PERIOD.

WHOEVER will make a careful examination of the brightness of a large number of stars, either in the sky, or, better, as photographed upon different plates, will be impressed with the vast number which show no perceptible variation. The discovery of variable stars is greatly aided when we are able to make a suitable selection for examination, either from their spectra or from their presence in clusters. Visually, we can never be sure that all the variables in a given region have been found, however carefully we may study them. Photography brings this problem more nearly within our reach, and a partial solution of it is illustrated in the accompanying figure. A photographic telescope was constructed having as an objective a Cooke anastigmatic lens with an aperture of 2·6 cm. and a focal length of 33·3 cm. This telescope was mounted equatorially, and the lens was alternately exposed and covered for intervals of exactly ten and fifty minutes by an electrical attachment. The polar axis of the mounting was displaced and the rate of the driving clock was increased, so that the successive images should be slightly separated. An eight-by-ten photographic plate was exposed in this instrument on April 21st, 1898, and eight successive images were obtained, the Greenwich mean times of the middle of the exposures being 13h. 49m., 14h. 49m., 15h. 49m., 16h. 49m., 17h. 49m., 18h. 48m., 19h. 48m., and 20h. 48m. The plate covered a region about thirty-three degrees square, whose centre was R.A.=1h. 2m., Dec.=+76·6°. The images of the stars in the corners of the plate were sufficiently good when visible to show very slight variations in light, but owing to their increased size the faintest stars were not shown. The greatest loss amounted to about one magnitude. If, now, any variable star having a period of less than fourteen hours was contained in this region, it is probable that at least one

maximum and one minimum would be photographed. The figure represents a portion of the plate described above, enlarged ten times to a scale of 60″=0·1 cm., and covers about one square degree. It therefore represents one-thousandth of the entire plate, the size of which on this scale would be two mètres, or nearly seven feet square. The entire sky, from the north to the south pole, could be covered by forty such plates, and it is proposed to do this as soon as the best method of taking the plates has been determined. The arrow indicates the variable star U Cephei, and its photometric magnitudes at the times the eight images were taken were 7·5, 8·1, 8·9, 9·1, 9·1, 8·3, 7·6, and 7·2. The three stars above it are +81° 30′, +81° 27′, and +81° 29′, which have the photometric magnitudes 7·9, 8·5, and 8·6. To separate the successive images various methods have been tried. The best of these seems to be stopping the driving clock for a few seconds every hour. By the above plan we hope to secure a complete list of all variable stars of short period brighter than the ninth magnitude at maximum whose variation exceeds half a magnitude and whose period is less than a day. Doubtless, many other variable stars of longer period, and stars of the Algol type, may also be incidentally found.

EDWARD C. PICKERING.

Harvard College Observatory.

THE ASTRONOMY OF THE "CANTERBURY TALES."

By E. WALTER MAUNDER, F.R.A.S.

THERE is one subject of which men never tire. They are always willing to be told of the way in which other men in different circumstances, in other lands, or in past ages, lived; of their habits and thoughts. Those who can tell us with certainty and vividness these things about other men will always claim our attention, and because of all such narrators he is one of the freshest and most natural, old "Dan Chaucer, the first warbler," as Tennyson so aptly calls him, will never lack an audience.

There are other reasons for his popularity.

> "Oh to be in England,
> Now that April's there,"

was Browning's wish, and Chaucer ever takes us to England in the freshest, fairest blossom of a spring-time, always young. A free-hearted contentment possesses him at all times:—

> "Sufficë thee, thy good, though it be small."

But more frequently this broadens out into a frank joyousness that refreshes us still, five hundred years after he has gone to sleep.

> "Unto this day it doth mine hertë boote,
> That I have had my world as in my time."

It is not, however, with Chaucer as a poet, or as a shrewd, observant kindly man of the world, that I am now concerned. Like one of his friars whom he scathes so sharply, yet so amusingly, I have to keep within my "lymytatioun," and to ask him, not for the sweet scent of the hawthorn, nor for the joyous notes of the woodland birds, but for any information which he may have to give as to the astronomy of his time.

From a poet so natural, so absolutely unpedantic, living long before the invention of the telescope and the revival of learning, and in a poem, the subject of which is the wayside talk, and free blunt banter of ordinary folk, one would not naturally expect to find a single astronomical allusion, nor, if we found any, that they should be accurate. Yet even in Tennyson, by far the most scientific of our modern poets, there are scarcely more astronomical allusions than there are in Chaucer.

On the first day of the month just past—"Saint Lubbock's Day"—a far greater pilgrimage than that which was "personally conducted" by the stout host of the Tabard Inn, set out from London and spread itself through Kent, in much the same direction as their forefathers, half a millenium before. But it may well be doubted if any of

the modern company—nearer nine-and-twenty thousand than nine-and-twenty—brought any astronomy into their holiday talk, or, if perchance a little science did leak out in conversation here and there, that it was anything but vague, uncertain, and at second-hand.

In spite of Board schools and University Extension lectures, we are not in all things the unquestionable superiors of our forefathers in the days of the Plantagenets. The men who deal in Chaucer's trade to-day—the writers of short stories—have multiplied as abundantly as our Bank Holiday makers have increased over the Canterbury pilgrims; but astronomy is carefully avoided by them unless perchance the hero has to be delivered from a tight corner by a total solar eclipse lasting an hour and a half, or the heroine to be treated to a sight of Venus between the horns of the crescent moon.

Chaucer's astronomy is of course of quite a different kind from any that would come into popular tales or conversation to-day. He knows nothing whatsoever of the spots on the sun, of Jupiter's belts, or Saturn's ring. His mind is vexed by no controversies as to whether the "gemination" of the canals of Mars is a real phenomenon, or a mere function of imperfect focussing, and the nebular hypothesis, either in its gaseous or "meteoritic" phase, passes him by untouched.

Still, astronomy, real astronomy, enters into his verse; the astronomy of the day and year; it is familiar and actual both to the poet and to his characters.

Never did any poem open with a fuller, fresher breath of spring than the Prologue to the Canterbury Tales:

"Whanne that April with his shoures sote
The droughte of March hath perced to the rote,
And bathed every veine in swiche licour,
Of whiche vertue engendred is the flour;
Whan Zephirus eke with his sote brethe
Enspired hath in every holt and hethe
The tendre croppes, and the yonge sonne
Hath in the Ram his halfe cours yronne,
And smale foules maken melodie."

It is Chaucer's habit to give his notes of time, sometimes by reference to the calendar, sometimes, as in the present passage, by the position of the heavenly bodies, the sun in particular. The eighth line in the above quotation has given rise to some unnecessary discussion. For in Chaucer's day the sun entered the sign Aries—not the constellation—about March 12th. By the first of April, therefore, the sun would have passed through more than half of the sign of the Ram. But the first two lines seem to point to April being far advanced, since its "sweet showers" have "pierced to the root," the "drought of March." Later on Chaucer expressly tells us in the Prologue to the "Man of Lawe's Tale," that it was then the 28th of April when the pilgrimage had nearly come to its close. We may therefore suppose that it is quite the middle of April when the poem opens, and that by the sun's "half course" in the Ram is meant the latter half of the sign, the half he passed through in the first fortnight of April, not the former half, which he passed in the last fortnight of March.

For it is clear from other passages that Chaucer quite understood when the sun entered Aries, for in the "Squier's Tale" we are told that Cambuscan—

"He let the feste of his nativitee
Don crien, thurghout Sarra, his citee,
The last Idus of March, after the yere.
Phebus the sonne ful jolif was and clere,
For he was nigh his exaltation
In Martes face, and in his mansion
In Aries, the colerike hote signe:
Ful lusty was the wether and benigne,
For which the foules again the sonne shene,
What for the seson, and the yonge grene,
Ful loude songen hir affections:
Hem semed han getten hem protections
Again the swerd of winter kene and cold."

The Ides of March fell on the 15th. For the following day we have a further note of time. The sun has entered Aries four degrees, that is four days.

"Up riseth freshe Canace herselve,
As rody and bright, as the yonge sonne,
That in the Ram is foure degrees yronne
No higher was he, whan she redy was,
And forth she walketh esily a pas,
Arrayed after the lusty seson sote."

So again in the "Nonne Preste's Tale" we have a day in May marked out for us in two ways, first by the calendar, next by the position of the sun in Taurus—

"Whan that the month in which the world began
That highte March, whan God first maked man,
Was complete, and ypassed were also,
Sithen March ended, thritty dayes and two.
* * * *
Cast up his eyen to the bright sonne,
That in the signe of Taurus had yronne
Twenty degrees and on, and somewhat more:
He knew by kind, and by non other lore,
That it was prime, and crew with blisful steven,
The sonne, he sayd, is clomben up on heven
Twenty degrees and on, and more ywis.
Madame Pertelote, my worldes blis,
Herkeneth thise blisful briddes how they sing,
And see the freshe floures how they spring."

Chaucer here evidently means that the sun entered Taurus about April 11th; hence it would enter Aries March 12th; but the exact day would vary of course with the position of the year with regard to leap year.

The knowledge of the sun's longitude day by day throughout the year strikes us as strange and unusual. But the above quotations, especially from a work so entirely natural and descriptive as the "Canterbury Tales," shows us how very general was the knowledge at the time, and is a clear indication that the sun's movements were both followed observationally with considerable diligence, and were published freely up and down the country in works to which many had access. Probably the great popularity of the Universities at the time, the attendance at which was, relatively to the entire population, something like fifty times what it is at present, had much to do with the wide diffusion of knowledge of this kind.

Another relation in which astronomy is introduced is a more practical one. The need to be able to tell the time of day has caused men in countries, and in times when clocks and watches are unknown or little used, to pay much more attention to the daily movements of the sun than we do. He still, of course, remains our great time-keeper; but there are so few who now resort to him directly for the information that his service in this connection is quite forgotten by the great majority.

It was not so in Chaucer's day. Then the sun dial, or, failing that, a rough estimation of the sun's altitude, was the means for telling the hour. In the Prologue to the "Persone's Tale," Chaucer gives us the method by which he concluded that it was four o'clock, and a little calculation shows that he was sufficiently correct.

"By that the Manciple had his tale ended,
The sonne fro the south line* was descended
So lowe, that it ne was not to my sight
Degrees nine and twenty as of hight.
Foure of the clok it was tho, as I guess,
For enleven foot, a litel more or lesse,
My shadow was at thilke time, as there
Of swiche feet as my lengthe parted were
In six feet equal of proportion."

* The meridian, that is to say.

Nor was Chaucer alone able to make such a calculation. The host of the Tabard, though "not depe expert in lore," could work out a similar but simpler problem.

"Our hoste saw wel that the brighte sonne
The ark of his artificial* day had ronne
The fourthe part, and half an houre and more;
And though he was not depe expert in lore,
He wiste it was the eighte and twenty day
Of April, that is messager to May;
And saw wel that the shadow of every tree
Was as in lengthe of the same quantitee
That was the body erect, that caused it;
And therfore by the shadow he toke his wit,
That Phebus, which that shone so clere and bright,
Degrees was five and fourty clombe on hight;
And for that day, as in that latitude,
It was ten of the clok,† he gan conclude."

It is in these two particulars, the apparent progress of the sun along the ecliptic during the year, and his course across the sky during the day, that astronomy entered chiefly into men's lives in Chaucer's day. There was as yet no suspicion that the earth was not the fixed centre of the solar system, or that the apparent motion of the sun along the ecliptic was due to the real motion of the earth. Ptolemy was still the master-mind of astronomy.

"Of alle men y blessed mote he be,
The wise astrologien Dan Ptholomee,
That sayth this proverbe in his Almageste:"

As with Dante, the planets revolved for Chaucer in successive crystalline spheres, for Europe had still two centuries to wait for Copernicus.

"And by his eighte speres in his working,
He knew ful wel how far Alnath was shove
Fro the hed of thilke fix Aries above,
That in the ninthe spere considered is."‡

But though he gives us evidence enough that the commonality believed in astrology more or less, he himself and the better classes had quite broken off from it. The "Chanones Yemanne" tell us—

"Sol gold is, and Luna silver we threpe;
Mars iren, Mercurie quicksilver we clepe:
Saturnus led, and Jupiter is tin,
And Venus coper by my fader kin."

But this is only the trade jargon of a confessed charlatan. The wife of Bath gives astrological reasons why learned men have little estimation for women, but is scarcely more serious in her argument than in her quotations from St. Paul.

"The children of Mercury and of Venus,
Ben in hir werking ful contrarious.
Mercury loveth wisdom and science,
And Venus loveth riot and dispence,
And for hir divers disposition
Eche falleth in others exaltation.
As thus, God wote, Mercury is desolat
In Pisces, wher Venus is exaltat,
And Venus falleth wher Mercury is reised.
Therfore no woman of no clerk is preised."

But the Frankeleine disposes of astrology or "magike naturel" in a very off-hand manner, though he describes the work of an astrologer in much detail.

"Which book spake moche of operations
Touching the eight and twenty mansions*
That longen to the Mone, and swiche folie,
As in our dayes n'is not worth a flie.
* * * *
"His tables Toletanes† forth he brought
Ful wel corrected, that ther lacked nought,
Nother his collect, ne his expans yeres,
Nother his rotes, ne his other geres,
As ben his centres, and his argumentes,
And his proportional convenientes
For his equations in everything.
* * * *
"Whan he had found his firste mansion,
He knew the remenant by proportion;
And knew the rising of his mone wel,
And in whos face, and terme and every del;
And knew ful wel the mones mansion."

Such was astronomy in Chaucer's day, very narrow and confined, without a hint of those wonderful revelations which the telescope and the spectroscope have brought to us, without a guess at that majestic order of which Copernicus had the first faint vision, which unfolded itself in three-fold stages to Kepler, and gave itself in the fulness of its completeness to Newton.

Yet, narrow as it was, hampered as it further was by its connection with the bastard science of astrology, already falling into merited contempt, astronomy had a real existence in Chaucer's time; real because a science of actual observation. Englishmen of that time lived out of doors, they were cooped up in no great cities, the sun himself was their great almanac and clock, and they were obliged to learn how to read him. That which they were able to learn from Nature may not have been much, but, at least, they learned it first hand.

Exactly the opposite condition of things prevails to-day. Immense volumes of knowledge have been opened to us of which our forefathers never dreamed; and the Press secures the ready and wide diffusion of every fresh advance. Yet there can be no doubt that in some respects a practical personal acquaintance with Nature is less general now than then. We may be quite sure that in Chaucer's day the veriest clodpole knew that the stars rose and set. There are probably millions in England who do not know it to-day; Sir George Airy thought it not safe to assume that even Cambridge undergraduates knew it.

There is a knowledge of science, of a sort, very widely spread to-day, but the utter nonsense which is often calmly printed in newspapers, and far more often inserted in popular stories, proves how thoroughly second hand it is. Such knowledge as that possessed by Tomlinson, of Berkeley Square,

"This I have read in a book, he said;
And this was told to me;
And this I have thought that another man thought."

is indeed better than nothing; but far better still is it to base one's knowledge upon one's own observations, one's own experiments, however crude, and to learn not from books alone, but from the lips of Nature herself.

* "His *artificial* day," *i.e.*, his *mean* day, from six in the morning to six in the evening, as contrasted with his *natural* day, from sunrise to sunset.

† It would be nearly a quarter to ten, apparent time, corresponding to the "fourth part" of the daily arc, "and half an hour and more."

‡ In other words, he knew the distance of the first star in Aries, the actual constellation, from the first point of Aries, the zero point of celestial longitudes. The actual stars and constellations are considered to be in the eighth sphere; the equal signs of the zodiac, the divisions of celestial longitude, in the ninth; the different planets occupying the first seven.

Notices of Books.

A Sketch of the Natural History (Vertebrates) of the British Islands. By F. G. Aflalo, F.R.G.S., F.Z.S. Blackwood. Illustrated. 6s. net. The "unambitious" aim of this book is that it shall serve as an "introduction to the many excellent handbooks to county fauna." For one man to attempt this task seems to us very ambitious, and to endeavour to write such an introduction in the space of

* Of the lunar zodiac. † The Alphonsine Tables.

five hundred small pages seems an insult to our fauna, which, if not very large, has been very closely studied. In our opinion anyone would be bound to fail in such an attempt, and certainly Mr. Aflalo has failed. It is not our intention to criticise each portion of the book. As a sample of the whole, let us take the largest division—the birds, to which two hundred pages are devoted. We have first to complain that, notwithstanding his acknowledged want of space, the author fills many valuable lines with assertions such as the following:—"The wood-wren used to nest in great abundance near Doberan, Mecklenburg, in May, 1890." Of what interest is it to those for whom this book is intended to know that the wood-wren nested near Doberan? Unless the book is intended to be nothing but a mere list, we presume that it would have for one of its chief objects the means of identifying species. The author's aim in this direction has been to enable the observer to recognize the live bird rather than the dead one. If it were possible to give sufficient information to be of any value for this purpose in a few words, the author's want of care—or is it want of knowledge—would prevent him from attaining his end. We are told, for instance, that the fire-crest may be distinguished from the gold-crest by the deeper orange of its crest. We venture to affirm that no one could distinguish the two birds by this means. The chief distinguishing feature of the fire-crest is that it has a black line through the eye. Again; we have to distinguish the turtle dove from other British doves merely by the "somewhat larger tail, which is edged with white, and by the black and white patches on the neck." From this we have to conclude that the turtle dove is, in general colouring, the same as the woodpigeon, stock dove, and rock dove. Of the statements that the common tern has the bill and tail orange-coloured, and that the Arctic tern is apparently *resident* on the east side of Scotland, we can make nothing. The many instances of this sort of slip-shod description render the book practically valueless for purposes of identification, and there is so little space for anything but the very briefest description of species that we cannot see on what grounds any value can be claimed for the book.

Birds in London. By W. H. Hudson, F.Z.S. (Longmans.) Illustrated. The birds of London have attracted a considerable amount of attention during the last few years, and Mr. Hudson's book is very opportune. The author's first idea was to write a handbook, giving lists of all the birds that are to be found in London, but this idea was subsequently discarded, and wisely, for what are the boundaries of London now, and who can tell what they will be in a few years to come? If we judge Mr. Hudson rightly, his chief objects in writing this book have been, first to show how badly wild birds are looked after in a great number of the parks and open spaces, and secondly, what a great delight and pleasure the birds are to the Londoner. In describing the bird life in the parks and open spaces, the author gives a great deal of sound advice as to how these places could easily, and often with little expense, be made enticing to birds, not only as visitors, but as permanent residents. We agree with Mr. Hudson in general on this point, but his arguments are sometimes a little one-sided. The Londoner no doubt is very fond of wild birds, and greatly enjoys seeing them in the parks, but the author would apparently have all the rhododendrons pulled up, and hollies and gorse planted in their stead, and a portion of the money that is spent on the flowers expended in providing for the accommodation of the birds. From an ornithologist's point of view this is only right and proper, but we should not care to say with the author, that "a gorgeous bed of tulips that has cost a lot of money is regarded by a majority of visitors with a very tepid feeling of admiration compared with that which they experience at the sight or sound, whether musical or not, of any wild bird." Mr. Hudson deals at length with "the cat question." It appears that cats, chiefly stray ones, swarm into the parks at night, and do incalculable damage to small birds, which roost in low bushes. On this subject again the author gives some good advice, and it is a subject into which he has evidently entered thoroughly. There are a number of amusing anecdotes about birds in the book, but we think one or two of them which bear the marks of imagination, or exaggeration, might have been omitted. It is always a pleasure to read Mr. Hudson's well-written books, and we feel sure that the present one will be found interesting, as well as instructive, by Londoners and those who take an interest in London birds.

Das Weltgebaude: a Popular Treatise on the Heavens. By Dr. M. Wilhelm Meyer. (Leipzig and Vienna: Bibliographical Institute. 1898.) The earth at present appears to be passing through the nucleus of a swarm of text-books of general astronomy. Now, a really magnificent specimen has come to hand from Germany, and though it labours under the disadvantage of being written in German, and printed in black letter, even an Englishman can enjoy the lucidness of Dr. Meyer's style, and the impartiality with which he discusses the theories that are not yet proven.

Assuredly the book is not of the dogmatic type. Dr. Meyer has perfectly realized that it is not the function of a text-book to formulate an astronomical creed, or to say the last word on any point of doubtful doctrine. He does not say, for instance, "I believe that Venus rotates on her axis in two hundred and twenty-five days, and I count all who believe not, schismatics"; neither does he assert that she rotates in some twenty-four hours. The same spirit of reasonableness attends him when he treats of the lunar surface, and leads him to supplement his actual description of the objects, by descriptions of terrestrial objects seen under similar conditions, and which they resemble or from which they differ. Thus, in the case of the lunar Apennines, he gives, beside it, a bird's-eye view of the Island of Corsica to emphasize the fact that moon mountains as a rule consist of single peaks arranged in a ring form, but that earth mountains are ranges which radiate in roughly parallel directions.

The arrangement of the matter is perhaps somewhat unusual, but there is much to be said for it. In the introduction there is a very full account of the optics of the telescope, with which is incorporated a description of some of the great telescopes of the world, others being left until Part II. The introduction also includes a full description of the photography and photometry of the stars and heavenly bodies, and of their spectral analysis. The rest of the book is divided into two parts, which deal with the heavenly bodies. Ordinarily in text-books these two sections are not distinct, but practically we believe that Dr. Meyer's arrangement will be at once more interesting and more intelligible to the general reader. But it presents the historical anomaly of the discussion of the results obtained from photographic and spectroscopic observations of the sun and heavenly bodies in the beginning of the first section, and the Ptolemaic theory towards the end of the second; the theories of the Milky Way, of double stars, of comets' tails, and the meteoritic hypothesis, some three hundred pages before the discovery of the law of gravitation.

But, even more than with the text, the reader is struck with the illustrations. These may be divided into three classes. There are those which are beautiful reproductions of drawings or photographs of the planets, sunspots and rice grains, corona, prominences, comets, stars, and nebulæ, and of

many other notable objects of interest. For such a collection of illustrations, exquisitely reproduced, too much praise cannot be accorded. There are, again, drawings or photographs of what may be called the terrestrial or laboratory analogies of celestial objects. Of such, we may mention a bird's-eye view of the Colorado Cañon and the Yosemite Valley, to illustrate lunar rills; of the volcano Kilauea, to compare with Jupiter's great red spot; and of some artificial electrical coronæ which bear a remarkably strong resemblance to the solar ones. The third class of illustration is most peculiar: it consists of highly coloured landscapes in some of which the artist purports to be situated on the planet Mars or Saturn, whence he views the setting sun or the globe shadow thrown on the rings. In others he views the giant Jupiter from one of its moons, or from our satellite observes an eclipse of the sun. We are not prepared to criticize the scientific accuracy of these observations, never having occupied these standpoints, though we have grave doubts as to whether the sun appears so large to an inhabitant of Mars, or whether Jupiter is so very like a Dutch cheese cut in two, in the eyes of its satellites. Certainly it does not seem obvious why the scenery on the moon, viewed in the light of its eclipsed sun, should present such delicacies of shade and colour, even in its shadows, when the moon in full sunlight is but black and white. There are also two landscapes of the earth seen under the illumination of the eclipsed sun and of the eclipsed moon. Here, indeed, there is a grave error, for in both cases the diameter of the luminary is made to measure fully ten degrees, and thus an utterly false idea of the magnitude of the corona is given.

A Text-Book of Botany. By Dr. E. Strasburger, Dr. Fritz Noll, Dr. H. Schenck, and Dr. A. F. W. Schimper. Translated from the German by H. C. Porter, Ph.D. (London: Macmillan & Co.) 18s. net. This handsome volume is a complete treatise on botany, including as it does sections on external morphology, histology, physiology, and systematic botany. The translator has had the good fortune to see his work undergo a general revision at the hands of Mr. A. C. Seward, M.A., the Cambridge University Lecturer in Botany, so that its suitability for English students is quite assured. The whole style of the book is admirable; the type, illustrations, and general arrangement leave nothing to be desired, while the coloured pictures of typical cryptogams and phanerogams, which are scattered throughout the text, are lifelike in their beauty. Such plates, which are, we believe, a new feature in ordinary text-books of botany, do more than any amount of verbal explanation to supply the reader with information which makes the recognition of the species in the field quite easy. Though it is perhaps too much to hope, yet we cannot but wish that somehow the introduction to the volume could get into the hands of that omnivorous person, the general reader. Showing as it does the relation which exists between animal and plant life; and making clear that as the line of development of animals and plants is traced back, through lowly and more lowly forms, the points of difference between them gradually vanish, until eventually it is found that they assimilate to one another's characteristics, and it becomes impossible to say whether the primitive organism is plant or animal; it is difficult to imagine a more fascinating piece of reading. In the same interesting way the work of Darwin, Müller, Schwann, and Pasteur is briefly reviewed, the part they each took in the elaboration of the whole subject being made quite simple and clear. We have not the slightest doubt that this text-book, like the German *Lehrbuch* from which it has been translated, will be long regarded as a standard work, and we wish it all the popularity it deserves.

SHORT NOTICES.

On Laboratory Arts. By Richard Threlfall, M.A. (Macmillan.) Illustrated. 6s. The student who desires to gain a practical knowledge of mechanical work in the chemical and physical laboratory will find in Mr. Threlfall's book a valuable auxiliary. The author aptly remarks: "It often happens that young physicists are to be found whose mathematical attainments are adequate, whose observational powers are correctly trained, and whose general capacity is unquestioned, but who are quite unable to design or construct the simplest apparatus with due regard to the facility with which it ought to be constructed." To such, this book forms a plank, so to speak, which will carry them safely across the difficulties generally encountered by the indifferent manipulator. Glass blowing, the making of vacuum tubes, glass grinding, and many other indispensable operations are described in detail, and helpful diagrams are interpolated here and there to illumine the text.

General Elementary Science. Edited by Wm. Briggs, M.A. (Clive.) Illustrated. 3s. 6d. Designed to meet the requirements of the modified syllabus of the University of London, this book is intended as a guide to general elementary science for the matriculation course. All aspirants for University honours, whether scientific or not, should at least acquire a knowledge of the fundamental principles of natural philosophy. Cramming, however, has attained the culminating meridian, when an editor endeavours to compress the sciences of mechanics, heat, light, electricity, and chemistry within the compass of a single volume scarcely large enough to convey a fair notion of any one of these sciences; and, keeping in view this flimsy groundwork, a smile might be tolerated when one reads that this meagre introduction is "to provide them (the matriculation candidates) with the means of recording observations with some degree of exactness." "*Some*," of course, is one of those elastic words which may represent any magnitude between zero and the infinitely great.

The Story of Life in the Seas. By Sydney J. Hickson, F.R.S. (Newnes.) Illustrated. 1s. With a thoughtful endeavour to instruct those who have not been trained in the alphabet of zoological technicalities, Prof. Hickson has, in this little book, avoided all the more intricate branches of marine zoology which, though of the highest importance to some, would not tend to encourage the general reader. Never losing sight of the goal he has set himself to reach, he conducts the reader through the trackless sea, so to speak, and by the help of a rich vocabulary—very slightly afflicted with unavoidable long words—conjures up a wonderful picture of the inhabitants of the great deep, including shallow-water fauna, surface-swimming fauna, and deep-sea fauna, as well as chapters on oceanography, commensalism and parasitism, and the origin of the marine fauna.

A Simple Guide to the Choice of a Photographic Lens. 1s. T. R. Dallmeyer, F.R.A.S. This booklet, written as it is in a clear and concise style, forms, with its explanatory diagrams, an excellent and trustworthy guide to photographers who wish to buy and use their lenses with greatest satisfaction.

The Story of Photography, by Alfred T. Story, is one of Messrs. Newnes' series of "Useful Stories." It answers its purposes very satisfactorily. The information given is plentiful and accurate.

BOOKS RECEIVED.

Astronomy for the Young. By W. T. Lynn, B.A., F.R.A.S. (Stoneman.) Illustrated. 6d. net.

A Dictionary of Bird Notes. By Chas. Louis Hett. (Jacksons', Market Place, Brigg.) 2s. 6d.

A Classification of Vertebrata, Recent and Extinct. By Dr. Hans Gadow. (Black.) 3s. 6d. net.

The Play of Animals. By Prof. Karl Gross. Translated by E. L. Baldwin. (Chapman & Hall.) 10s. 6d.

Outlines of Vertebrate Palæontology. By Arthur Smith Woodward. (Cambridge University Press.) Illustrated. 14s.

Forty-fifth Report of the Department of Science and Art of the Committee of Council on Education. (Spottiswoode.) 1s. 10d.

Chemical Analysis. By W. Briggs and R. W. Stewart. (Clive.) 3s. 6d.

"INSECT MINERS."—II.

By FRED. ENOCK, F.L.S., F.E.S., etc.

A NUMBER of very interesting miners, together with their parasites, may be observed in leaves of sunflowers, carnations, columbine, etc., etc.; and in the shoots of black currant bushes, the larva of the pretty currant clear-wing moth, *Sesia tipuliformis*, is found, but more frequently by

the blue tits than by gardeners, who attribute the broken twigs to these useful birds. I know that the majority of gardeners look upon anyone as insane who would say a good word for the sparrow, but I am proud to own them as friends, though they do pinch the crocuses and other things. In my insect diary I have many records for good as well as for evil deeds. I have frequently watched sparrows examining the lime trees in search of the brindled beauty moth, *Biston hirtaria*, and seen them kill and eat a number of females—each of which would lay over six hundred eggs. Again, that great miner the wood leopard moth, *Zeuzera æsculi* (whose larvæ work such havoc among trees of all kinds in our parks and gardens), is a favourite morsel of the sparrow. I turn to my diary for 1873, and find an entry to the effect that every ash tree (over thirty) on the right side of Hanley Road, N., was infested with wood leopards, which emerged about five o'clock in the afternoon. On some trees over a dozen were to be seen drying their wings. Further observation showed dozens of sparrows "collecting" and eating these savoury insects. I noted the same thing going on at Finsbury Park, where I pointed out several infested trees to the late Mr. Thomas Cochran, Superintendent, who had them immediately cut down and opened, much to the wonder of the staff, who had no idea such "miners" could bore through and through

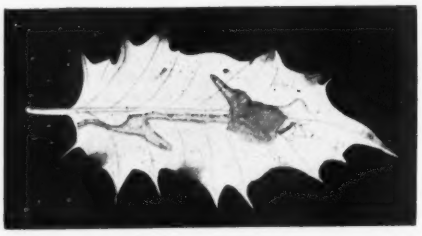


FIG. 9.—Holly Leaf mined by Larva of *Phytomyza aquifolii*. (Natural size.)

the solid ash trunks. Where the wood leopard failed the huge larva of the goat moth (*Cossus liquiperda*) took up the work of destruction. In the year 1878, when living near Finsbury Park, I noted a small willow tree in my next-door neighbour's garden which appeared to be infested with these caterpillars. Soon after we were astonished to find a large larva in the kitchen one morning, but though, according to Pliny, the Romans used to consider this stinking goat moth larva a luxury of the table, I did not feel disposed to prove it, though I could not understand the visit. However, others continued to arrive almost daily in various parts of the house, until I obtained permission from my neighbour to examine the willow before mentioned. It was not more than five inches in diameter, and, when broken up, I found it full of larvæ of *C. liquiperda*, varying from an inch and a half to four inches long! These, added to those which had visited us, all told, totalled up to one hundred and nine! But how many beside went over the walls the other side it is impossible to say. What a feast for anyone so inclined! I have seen a sparrow attack and destroy one of these large moths. Only last week I found the mutilated remains of a wood leopard in my own garden, where from a small pear tree I cut out one of these larvæ, but the damage had gone too far, as the "miner" had bored right up the central stem and the tree died.

We must not forget that sparrows kill great numbers of "daddy longlegs" before most people are awake. We all know how plentiful "green fly" has been on every plant this dry season; I, for one, have been much indebted to the sparrows for their persistence in picking off immense numbers of this pest.

"Seeing is believing," and I only write of the things which I have seen, and feel it to be a duty to say a kind word on behalf of the much-abused sparrow.

The holly leaves are sometimes sorely affected by the

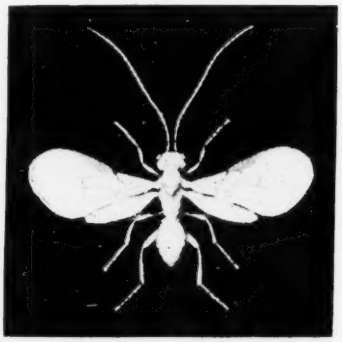


FIG. 10.—Parasite of Holly Fly. (×12 Diameters.)

larva of *Phytomyza aquifolii* (Fig. 9), a miner which, for obvious reasons, has things pretty much its own way, except for the industrious parasite (Fig. 10) which does its best to check the advance of this disfiguring larva.

To those who grow raspberries "the maggot" ought to be familiar, but it is astonishing how seldom the cause of a bad crop is detected. This is owing to the fact that inquiry is generally made too late, and should "opportunity be neglected" sorrow is sure to follow.

The month of May is the best—I might say the only time when any steps can be taken to destroy this miner, which is, when full grown, a little over a quarter of an inch long—a chubby little pink maggot—which has during the winter been securely protected in a tiny covering among the earth at the foot of the canes. In the spring it ascends until it reaches the buds just breaking into

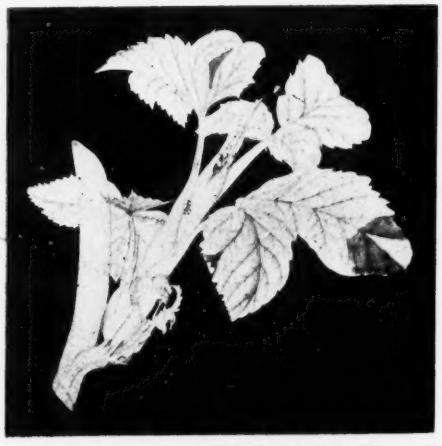


FIG. 11.—Raspberry Shoot affected with "the Maggot" of *Lampronia rubiella*.

growth. Into the bud it bores a minute hole (Fig. 12), which is frequently hidden away by the scale. When once inside it is safe from observation, and it quietly goes on with its mining right up the centre of the fruit-bearing shoot, the only outward indication of its presence being an

occasional darkening of portions of the leaves (Fig. 11), and always the presence of minute pellets of frass, which are forced out at the aperture at the tip of the shoot, and, falling, rest in the axils of the leaves (Fig. 11). Directly these signs are noted any of the shoots so affected, on being split up, reveals "the miner"—plump and fat—with plenty of room to move up and down. All shoots containing a maggot have (as shown at Fig. 12) the centre eaten clear away, and all chance of fruit-bearing is gone. The larva sometimes leaves its burrow and pupates among the dead leaves at the base of the shoot, but it generally remains inside to undergo its change. The pupa has rings of minute spines around the margins of the segments, by the aid of which it can lever itself up to the top of the shoot, from which the raspberry moth emerges in the course of a week or two.

The great point to bear in mind in connection with this raspberry pest is that it remains but a few weeks in the shoot, and that it is there the latter part of May. This,

FIG. 12.—Section of Raspberry Shoot showing larva of *Lampronia rubiella*.

then, is the time to destroy it, which must be done at the sacrifice of many canes, or even the whole crop. When the moths have escaped—in early June—it is impossible to prevent eggs being laid by them for the next season's brood. Catching the moths (in exactly the same manner as by entomologists) would materially lessen them if carried out in a systematic manner, and until some such work is carried out these insect miners will go on increasing.

Fruit and flower growing has now been brought up to great perfection, but we are still far behind in systematic work for coping with insect pests.

BOTANICAL STUDIES.—V.

ASPLENIUM.

By A. VAUGHAN JENNINGS, F.L.S., F.G.S.

IN the moss plant which formed the subject of our last study* we found that, as in *Jungermannia*,† the life-history consisted of two distinct stages. It was observed that the leafy moss-stems of *Mnium* carried more or less evident "flowers" at their tips, containing either the egg-bearing Archegonia or the fertilizing Antheridia; and that from the former there arose the slender stalk and drooping capsule which we know as the "moss-fruit." In other words, that there was a green, leafy *Oöphyte*, or egg-bearing plant, from which grew a distinct type of plant, the *Sporophyte*, whose spores in turn developed the form of the parent Oöphyte.

Bearing this in mind, and looking among the higher flowerless plants, such as the ferns and their relatives, for a type to study in continuation of our series, we should come to the subject with preliminary expectations that will cause us some trouble. Naturally enough we shall expect that a fern, say the little spleenwort here figured (common in the crevices of stone walls), may be regarded as a plant comparable to a moss-plant, though of much higher development and greater complexity of internal structure. We shall look at the fronds expecting to find something equivalent to the moss "flowers," and showing under the microscope more or less similar groups of Archegonia and Antheridia.

It will be found that the only structures on a normal frond which suggest a fructification, are the oblique lines on the under surface of its pinnæ; light coloured in the young plant, but larger, browner, and dust-like on the older parts. If we cut a thin section with a razor across one of the younger pinnæ, we shall find something similar to the central figure in the illustration. A number of oval bodies borne on longer or shorter stalks, rising from superficial cells of the leaf, though partly covered by a thin irregular membrane rising from one side. The oval bodies have evidently a distinct cellular wall, and the older ones enclose a mass of dark granular cells in a condition of active division. There is evidently nothing that can be compared to an archegonium. What, then, are these structures? Are they antheridia? It seems not improbable from their appearance when young, but an examination of the older ones will not confirm the idea. If we take one of the older pinnæ and scrape off the brown material from the under side, we find the structures shown in Figs. M and N. They are stalked, thin-walled cases, with a dark layer of thick cells running round some two-thirds of the margin; in the interior is a dark mass which, when a ripe case bursts, resolves itself into a number of brown bodies with thick, rough walls. There is, evidently, nothing here like the minute, free-swimming bodies we saw discharged from the moss antheridium; but, on the other hand, these bodies have a strong resemblance to the spores of the moss and the liverwort.

It is, in fact, evident that the oval cases are *Sporangia*; but are they equivalent to the spore-capsule of *Mnium* or *Jungermannia*? If so, they are very minute and simple in structure; and, further, should be found to arise from fertilized archegonia. Referring again to the section, or making new preparations, no trace of archegonia can be found, and it is evident that some different line of study must be adopted. Suppose we "plant" the spores and see what becomes of them.

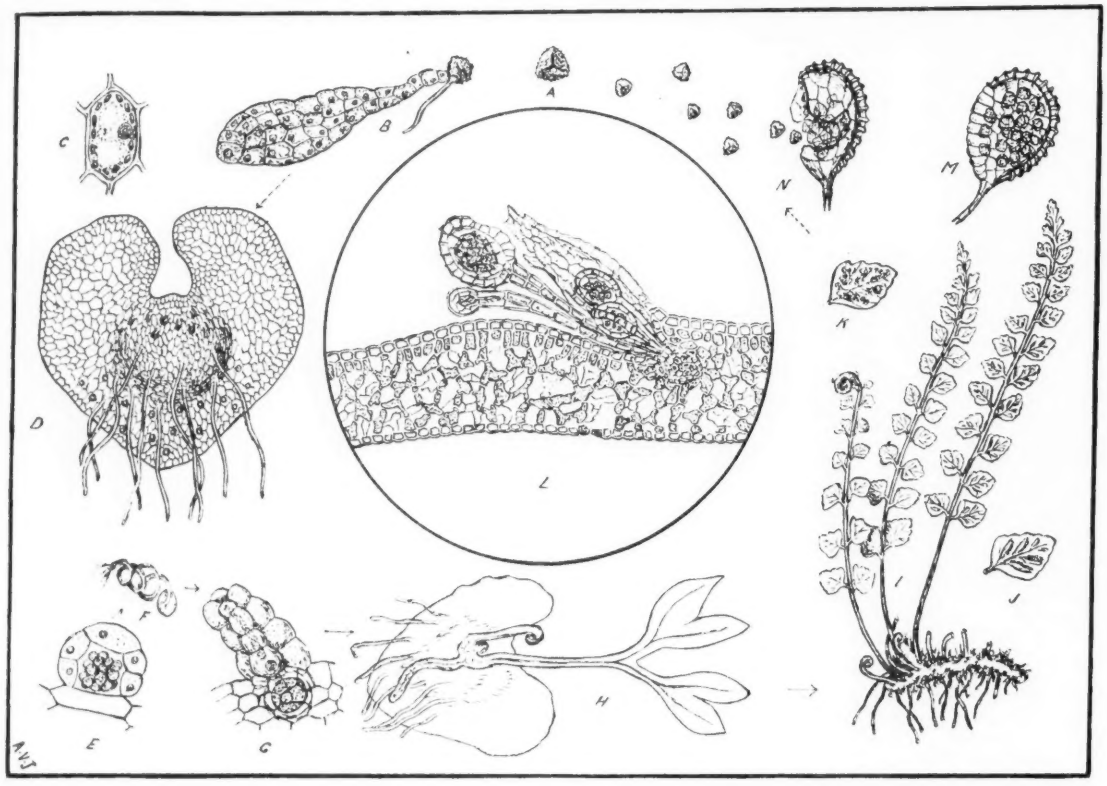
If a number of the spores are scattered over a layer of mould or on the side of a flower pot, and kept moist, it will soon be seen that the surface is acquiring a green colour, and a pocket-lens will show that this is due to the growth of a number of separate little green discs. Under the microscope these may be seen distinctly to originate from the germinating fern-spores. At first they are merely narrow plates of chlorophyll-containing cells, but by the continued division of a triangular cell at the tip, and by the rapid growth and division of cells at the side of it, a heart-shaped or bi-lobed structure is ultimately

* KNOWLEDGE, July, 1898. † KNOWLEDGE, May, 1898.

produced. This becomes thicker in the centre owing to division of cells in a horizontal direction; and from the under side are developed slender root-hairs or rhizoids, which serve both to anchor the plant to the soil and to collect food material therefrom.

Thus the cell-plate is able to lead an independent existence, feeding itself from the air and the soil like other green land plants. Yet it shows no tendency to differentiate into root, stem, and leaf, or to acquire any of the characteristics of a fern. Longer observation will show also that it does not continue to increase in size; many will dry up and disappear, but from some of them new green shoots will be seen to rise growing upward from by dark spots distributed more especially over two regions. The more conspicuous are small round bodies scattered among the bases of the root-hairs; while another group occurs above, round the indentation at the apex.

It will be found quite possible to get a good idea of the form and nature of these structures by carefully focussing the microscope, or even by dissecting them out with needles; but it is far preferable to harden some of the plants in spirit and then cut thin sections through them. The latter group referred to will be found to have all the essential characteristics of Archegonia, a typical egg cell lying in a rounded cavity, and above it a "neck" composed



A.—The Fern Spore. B.—Germination of the same, producing the young Oöphyte or Prothallus. C.—One of the Cells of the Prothallus, showing the Protoplasmic Contents, with Nucleus, Vacuoles, and Chlorophyll bodies. D.—The Prothallus, seen from the under side. The small round bodies among the root-hairs toward the apex are *Antheridia*; those below the notch are the *Archegonia*. E.—An *Antheridium* as seen in Section, with the mass of developing Antherozoids within. F.—One of the Antherozoids (or Spermatozoids) set free. (Highly magnified.) G.—An *Archegonium* ready for Fertilization. H.—A withered Prothallus, with a young *Fern Plant* (*Sporophyte*) growing from it. I.—*Sporophyte* of Asplenium trichomanes, showing the creeping Stem (Rhizome) and young Fronds rising behind its apical growing point. J, K.—Younger and older Pinnæ of the Frond, showing the Sori on their under surface. L.—Section through a Pinna and *Sorus*, showing the *Sporangia* in different stages of development, partly covered by the *Indusium*. M.—A ripe Sporangium with enclosed Spores. N.—A burst Sporangium discharging the Spores.

their surface. These are evidently new structures, not further growths, since the heart-shaped cell-plate still remains, though shrinking and withering round their base.

The explanation of these phenomena can only be arrived at by a closer study under the microscope.

If a medium-sized disc, one about a quarter of an inch across, is mounted in water and examined with a moderate magnifying power, it will be seen that the regularity of the cell arrangement is sometimes broken of several rows of cells surrounding a central passage. The wall of the chamber round the egg cell is not so distinct as in the moss, since the whole base of the structure is here embedded in surrounding tissues; the neck is also much shorter and wider, but these are mere details, the organ is evidently an *Archegonium*.

That the round bodies occurring among the rhizoids are similarly true *Antheridia* may be readily proved if one of the darker-coloured riper ones is selected and burst by light pressure on the cover glass. A mass of small cells

will escape into the surrounding water, and shortly each will be seen to take the form of a spirally coiled spermatozoid with a more or less defined disc at one end and a tuft of cilia at the other.

It thus becomes evident that these little bodies, which can be found in any greenhouse round growing ferns, though not so easy to distinguish out of doors, are true egg-bearing plants. They are, in fact, the real oöphyte stage in the fern-plant's life-history, and we are forced to the conclusion that we must look on them as the equivalent of the moss-plant with its stem and leaves, and regard the familiar fern as the representative only of the stalked capsule or sporophyte of *Mnium* and *Jungermannia*.

The two generations have, as it were, changed places in respect of size, conspicuousness, and elaboration of structure.

While it is impossible to exaggerate the importance of this "alternation" in the life-history, it remains difficult to decide whether we should regard the two stages as fundamentally different, or look on them as extreme specializations on distinct lines of a type with double potentiality. Thus, we cannot overlook the facts that in a few exceptional cases the formation of Archegonia can be dispensed with, and the prothallus may grow out vegetatively into a sporophyte ("*Apogamy*"); while, on the other hand, the tissues of a frond may, in rare cases, develop prothalli without the intervention of spores ("*Apospory*").

We have, in fact, crossed a wide gap in the continuity of vegetable life. We have passed from a type in which the sporophyte grows from, and is physiologically dependent on, the parent egg-bearing plant, to one in which the oöphyte generation is small, inconspicuous, transitory, and of simple structure. The sporophyte has become a highly specialized growth, with complicated systems of tissues like those of flowering plants; ranging through an infinite variety of forms, from the moss-like fronds of the filmy ferns to the rigid tree trunks of the Cyatheas and Alsophilas of the Tropics.

With the detailed structure of this sporophyte we are not here concerned; but to complete our summary of the life-history the cycle of reproduction may be summarized as follows:—

Division of the fertilized egg-cell produces a fern-embryo which develops a primary root, leaf, and stem growing-point long before the final decay of the Oöphyte or Prothallus. When the latter has dried up and disappeared the stem of the fern-sporophyte is in active growth; producing successive leaves or fronds behind the progressive apex, and establishing firm connection with the soil by its numerous roots. The fronds from the first perform all the functions of leaves in the vital economy of the organism, and in their older stages take their part in the reproductive cycle by developing Sporangia. These, in the case of the true ferns, are formed each from an epidermal cell, though as numbers of such cells are active together the result is usually a group or *Sorus* of sporangia. The form of the sporangium varies, and special forms characterize particular groups, but in all our common ferns the type is that shown in the figure. The position and shape of the *sori*, and the form of their membranous covering or *indusium* when present are characters of great importance to the systematic botanist. Through the whole series of true ferns, however, whatever their variety of appearance, the spores are of *one kind only*, and when they germinate produce a free green prothallus such as we have observed.

Having thus got some idea of the life-history of a fern, it only remains to see if we can get any glimpse from this standpoint, either backward or forward, along the lines of plant evolution.

Looking downward, it is very remarkable that we can see no evident links connecting the fern-type and the moss-type. It is possible to imagine a moss in which leaves might be formed on the seta, or in which the sporophyte might root itself and live after the oöphyte had perished, but as a matter of fact we do not know of any such types. It is also possible to imagine a moss-capsule becoming complicated in structure by internal division into chambers, owing to certain cell layers not forming spores; and later by the separation of these layers so that the whole sporophore became a compound structure. Prof. Bower has shown how the various types of "fructification" in the vascular cryptogams may in this way be compared with one another, and with some relatively simple ancestral type. It is, of course, neither necessary nor reasonable to suppose the fern derived from a specialized moss-type, but it is probable that the whole series of the vascular cryptogams—ferns and their relatives—might, if the intermediate links were still existing, be traced back to some form having relationship with both mosses and liverworts.

Looking in the other direction, the question arises, what is likely to be the next stage in the series if the subordination of the Oöphyte generation continues? It will be some plant in which the prothallus is still smaller, more ephemeral, and less independent. In our next study we may find that this link in the chain between the lower and higher plants is also easily obtainable, and almost equally easy to observe.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

COMETS.—Though we have recently had a numerous display of comets they do not seem to have furnished any special instance of brilliancy or peculiarity of appearance. The positions of the objects referred to are, in the majority of cases, unfavourable. Perrine's comet of March 19th is now exceedingly faint, and during September will be almost stationary in about R.A. 6h. 32m. Dec. fifty-one degrees north. The comets of Coddington, Encke, and Perrine (June 14th) are too far south to be favourably seen. Giacobini's comet is becoming very faint. Wolf's periodical comet, is still visible in the morning hours, but it requires a good telescope to show it, as it is by no means a conspicuous object. The following is an ephemeris by Thraen for Berlin mean midnight:—

COMET WOLF.

Date. 1898.	R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.
September 11	6	6	7	+9	31·8	153
,, 15	6	13	38	+8	24·2	151
,, 19	6	20	45	+7	14·2	150
,, 23	6	27	26	+6	2·2	148
,, 27	6	33	41	+4	48·4	147

During September its brightness remains practically constant at 2·6. From the ephemeris it will be seen that the comet moves slowly to south-east passing from the north-easterly limits of Orion into the head of Monoceros. On September 23rd the comet will be in conjunction with the 6th mag. star 12 Monocerotis, and about one and a-quarter degrees north of the star.

Meteors.—Fireball of July 14th.—A brilliant fireball, apparently as large as the moon, was seen on July 14th at 9h. 50m. by Mr. Murrell Dawnay from a position about two miles off Beachy Head. The path of the fireball

was roughly estimated as from 280° − 14° to 310° + 8°, but no other descriptions of it have come to hand.

FIREBALL OF JULY 26TH.—Mr. F. C. Dennett, of Dalston, E., writes: "There was a remarkable meteor on July 26th, at about 9h. 12m. It appeared from behind houses and disappeared behind clouds about twenty degrees N.N.E. of the zenith. Size a-quarter to a-third that of the moon. The colour was green, very decided, and its trail, perhaps four degrees in length, was red. Its motion was fairly rapid, and its path was nearly south to north, perhaps ten degrees east of the meridian." Mr. C. Grover at Lyme Regis describes the time as 9h. 10m., and says: "The fireball started from a point a little south of east at an altitude of about fifteen degrees, and vanished in about north-east, at a height of about ten degrees. At first it appeared like a small star, but rapidly increased until it was far brighter than Venus, and finally disappeared in a shower of sparks. The colour was most remarkable—a brilliant, dazzling green—so intense as to be quite startling. The sky was very hazy at the time." Mr. W. Lucking, of Berden, Herts, reports, in a letter to Prof. Herschel, that on July 26th, 9h. 10m., a magnificent detonating fireball passed over that village. There was a vivid illumination of the landscape, and, on looking upwards to ascertain the cause, a fireball with a red train was observed moving northwards nearly from the zenith. The fireball burst with a loud report, which was compared to that of a cannon fired at a short distance. At Albury, Herts, a loud detonation occurred, and is described as being simultaneous with the disruption of the meteor. People indoors thought there must have been an explosion at the Waltham Powder Mills, and were much alarmed. The fireball was also seen at Maldon and other places. From a comparison of the various accounts the approximate real path of the object appears to have been from above a point twenty-five miles west of Dieppe, France, to March, Cambridge. The height was seventy-three miles at first, and twenty-seven miles at the end. The meteor had a long flight of about one hundred and ninety-one miles from south to north, and a probable radiant at 269° − 23°. It must have passed over the zenith of Berden at a height of thirty-eight miles, so that a detonation of the meteor would have taken three minutes to reach observers there. This is, however, a relatively short interval, and quickly passes when people have been surprised by an unexpected phenomenon, so the statement that the sound came simultaneously with the meteor's explosion may not be quite correct.

FIREBALL OF AUGUST 1ST.—Mr. W. Lascelles-Scott, of Romford, reports that just before 10h. 9m. P.M. he saw a magnificent meteor about eight times the brilliancy of Jupiter: "It passed directly overhead, and apparently describing a curve upon a vertical plane in the direction S.S.W. by S. to N.N.E. by N., descended until it quietly disappeared, after traversing more than one-third of the heavenly dome."

The Perseids.—This long-continued shower commences about the middle of July, and the sky being almost free from moonlight at this epoch, an attempt was recently made to observe a few of the earlier members of the display, Prof. Herschel, at Slough, watched the north-west portion of the firmament on July 13th, 14th, and 15th, and noted nineteen meteors, which included two Perseids, one seen on July 14th at 11h. 25m., and the other on July 15th at 10h. 59½m. At Bristol observations were commenced on July 16th, when three small Perseids were recorded amongst fifteen meteors seen during a watch of three hours. On later nights of July a few other Perseids were registered, both at Slough and Bristol, but they were not sufficiently numerous on any particular date to indicate a good radiant.

On July 30th a fine Perseid appeared in the moonlit sky at 10h. 43m., and was fortunately observed by Prof. Herschel and the writer. The real path of the meteor extended over fifty-seven miles, from Northampton to Burford, and it fell from a height of eighty-one to forty-seven miles. Its velocity was thirty-six miles per second, and the radiant point, from the combined paths, was at 23° + 53°, which is several degrees west of the normal place of the Perseid centre on July 30th. At Slough the meteor was observed at a considerable distance from its radiant, and a slight inaccuracy in recording the direction of flight would throw the radiant some degrees away from its correct position. At Bristol the meteor was much foreshortened close to its radiant, and it left a dense streak, broken in the middle, just south of α Cassiopeiæ.

Among the minor showers observed in July, there was a prominent display of Cygnids from a radiant at 315° + 47°. This is a well-known position, and furnishes quite a distinct stream to that of the August Cygnids, which were very active in 1893, from a radiant at 292° + 53°.

There was also a well pronounced radiant in Hercules at about 249° + 37°, and very few Aquarids were recorded, but there was a display of long-pathed meteors from a centre at 338° − 25°, near Fornalhaut.

THE FACE OF THE SKY FOR SEPTEMBER.

By A. FOWLER, F.R.A.S.

THE Sun has been free from spots for several days together during the last two months, but several spots of moderate size have been observed. Bright faculæ have been frequently seen. It is, of course, impossible to say what may happen during the present month.

Mercury will be at inferior conjunction on the **5th**, and will reach his greatest elongation of 17° 51′ W. on the **21st**. He will, therefore, be a morning star during the latter part of the month. On the **21st** he will cross the meridian 1h. 12m. before the Sun, his declination being 8° 20′ N., while that of the Sun will be 0° 36′ N.

Venus is an evening star, and will be at greatest eastern elongation on September **21st**, 46° 27′ E. of the Sun. She is, however, so far south, and sets so soon after the Sun, that her appearance is not very striking. On the **21st** she will set about an hour after the Sun. At the middle of the month, a little more than half of the disc will be illuminated. On the **19th** it will be interesting to observe the planet in close proximity to the Moon, the two being in actual conjunction about 7 P.M., shortly before they set. At the time of conjunction the Moon's age will be 3d. 19h., and Venus will be 1° 28′ north of the Moon.

Mars does not rise until between 10 P.M. and 11 P.M. during the month, and he is too far distant for profitable observation with small telescopes. It is, however, always interesting to follow the apparent movement of this planet. During the month he pursues a direct path in Gemini, along a line running a little north of the star η, south of ϵ, to a little north of δ. His apparent diameter increases from 6·4″ to 7·2″. There will be a daylight occultation of this planet on the **9th**, the disappearance taking place at 1.31 P.M., at a point 95° from the vertex, and the reappearance at 2.19 P.M. at 215° from the vertex. The Moon will be twenty-three days old, so that the disappearance will take place at the bright limb. A telescope will, of course, be necessary to observe the occultation, but as the Moon will probably be visible to the naked eye, an equatorial will not be essential.

Jupiter will be an evening star during the month, but he is too near the Sun for useful observation. He will be

in actual conjunction with the Sun on October **13th**, and the satellites will not be observable from September **15th** to November **12th**.

Saturn is still an evening star, at the middle of the month remaining above the horizon for about two and a half hours after the Sun has set. He is in the constellation Ophiuchus, but may perhaps be better recognized from his position of about six degrees north of Antares.

Uranus passes from Libra into Scorpio, but is too far south and too near the Sun for convenient observation. His path is from about one-third to one-half the distance from λ Libræ to ω Scorpii.

Neptune, still in Taurus, rises about 11 P.M. at the beginning of the month, and about 9 P.M. at the end. He is a little to the north-east of ζ Tauri.

The Moon will enter her last quarter on the **7th** at 10.51 P.M.; will be new on the **16th** at 12.10 A.M.; will enter her first quarter on the **23rd** at 2.39. A.M.; and will be full on the **29th** at 11.11 P.M. At the full the phenomena of the Harvest Moon will be presented to us; that is, she will rise almost full at about the same time on several successive evenings. This is illustrated in

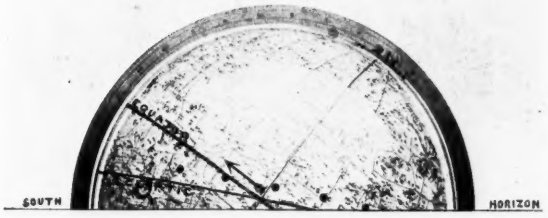


FIG. 1.—Illustrating the Rising of the Harvest Moon.

Fig. 1, showing the Moon's position on the celestial sphere at the times of rising, from September **27th** to October **1st**, as seen from outside. The direction of the diurnal motion being indicated by the arrow, it is at once evident why the times of rising vary so little. At the time of setting, the ecliptic is no longer nearly coincident with the horizon, as will appear from Fig. 2, and the intervals

FIG. 2.—Illustrating the Setting of the Harvest Moon.

between the times of setting on successive days are longer than the average. The following are the times of rising and setting of the Harvest Moon at Greenwich:—

	Rises.	Sets.
September **27th** ...	4.29 P.M. ...	2.38 A.M.
,, **28th** ...	4.47 ,, ...	4.1 ,,
,, **29th** ...	5.4 ,, ...	5.21 ,,
,, **30th** ...	5.22 ,, ...	6.41 ,,
October **1st** ...	5.42 ,, ...	7.59 ,,

Conveniently observable minima of Algol will occur on the **12th** at 11.27 P.M., and on the **15th** at 8.16 P.M.

Observers interested in variable stars may be reminded that a maximum of Mira Ceti is probably not far distant.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 10th of each month.

Solutions of August Problems.

(By J. Nield.)

No. 1.

1. Q to QR2, and mates next move.

No. 2.

As pointed out by W. de P. Crousaz only, Kt to R2 will not solve this problem, on account of the reply Kt to K7.

CORRECT SOLUTIONS of No. 1 received from Alpha, W. Clugston, H. Le Jeune, G. G. Beazley, J. M'Robert.

Mr. A. C. Challenger writes to say that the unsoundness of his problem in the July number was due to the absence of a White Pawn at KB2.

W. J. Bearne.—After 1. QK2ch, K to Q5, 2. Kt Kt4 is not mate.

W. Clugston.—July solution correct, as you will have seen.

F. W. Andrew.—Thanks for the problem; it is marked to appear next month, and a copy shall be sent to you.

J. Nield.—Have posted copy as requested. Can you account for the difficulty in No. 2?

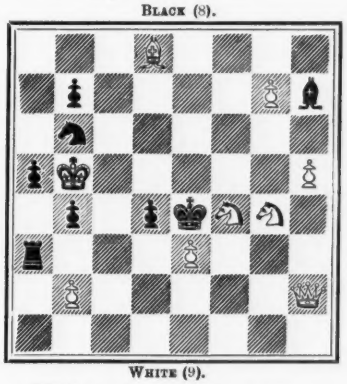
A. C. Challenger.—Many thanks for the explanation. The original being no longer available, it is impossible to say whether the omission was there or not. Judging by the number of pieces, it seems perhaps probable that the omission was made as you suggest. We shall be glad to receive the substitutes.

PROBLEMS.

No. 1.

By B. G. Laws.

BLACK (8).



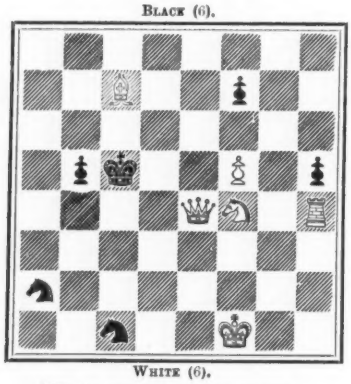
WHITE (9).

White mates in three moves.

No. 2.

By A. C. Challenger.

BLACK (6).



WHITE (6).

White mates in two moves.

CHESS INTELLIGENCE.

The Lee-Teichmann match resulted in a victory for Mr. Teichmann by three games to one, with five draws. Such a score does not show any marked superiority on either side.

The final score in the Vienna tournament was as follows, Herr Schwarz's score being cancelled:—

H. N. Pillsbury	28½	tie for first and second prizes.
S. Tarrasch	28½	
M. Janowski	26½	third prize.
W. Steinitz	24½	fourth prize.
C. Schlechter	22½	fifth prize.
A. Burn	21	tie for sixth prize.
M. Tchigorin	21	tie for seventh prize.
G. Maroczy	20½	tie for eighth prize.
P. Lipke	20½	tie for ninth prize.
S. Alapin	19	tenth prize.
E. Schiffers	18	special Chess Club prize.
G. Marco	17½	
J. H. Blackburne	17	special prize.
J. W. Showalter	16	
C. Walbrodt	15½	special prize.
E. Halprin	15	special prize.
H. Caro	13½	
D. G. Baird	9	
H. W. Trenchard	6	

On playing off the tie for first and second prizes, Dr. Tarrasch won the first prize (£250) by two games to one, with one draw; Mr. Pillsbury taking the second prize (£166).

Dr. Tarrasch lost only three games out of thirty-six played, a very fine performance; Mr. Pillsbury lost five, but drew considerably fewer games, this result being in accordance with the styles of the two players. M. Janowski lost both games against Lipke and Halprin. Mr. Steinitz's only double defeat was at the hands of Janowski, but he drew more games than usual, as also did Burn. Herr Schlechter, as usual, drew about half his games, losing only six. He was the only player to beat Mr. Burn in both rounds. Probably the latter had resolved not to draw at all costs, with the usual result. Tchigorin, like his old rival Steinitz, lost both games to Janowski, and to him only. Maroczy hardly fulfilled expectations. He drew more games than even Schlechter. Lipke also was insatiable in the matter of draws, but he could not get one against Steinitz. Alapin had an excellent score at the end of the first round, but he failed in the second. Schiffers, on the contrary, started badly, and altogether failed to do himself justice, while Marco hardly played as well as he has lately. Blackburne drew no less than twenty games. When playing his last game (against Caro) he found himself in the anomalous position of standing to lose £4 if he won the game. Naturally he lost it, thereby winning the £12 prize for the best score against the prize-winners. Showalter again disappointed his admirers, while Walbrodt has his own carelessness to thank for his low position. He forfeited two games through arriving late. The last three are representatives of London and New York; evidently the Anglo-American cable match is not quite up to the standard of a first-class international tournament. Altogether, the present tournament is one of the strongest ever known, the players on the whole being superior to their predecessors in the Vienna tourney of 1882, though Lasker and Charousek were needed to make it complete. The winner enhanced his already great reputation; of the others, the chief honour rests with Schlechter and Burn.

Several of the Vienna competitors are now playing in the tournament of the German Chess Association at Cologne. Herr Cohn, the well-known Berlin amateur, was leading at the end of the tenth round, closely followed by Mr. Burn. Of the remainder, Steinitz, Charousek, Tchigorin, and Schlechter were making the best scores, and Herr Schallopp the worst.

KNOWLEDGE, PUBLISHED MONTHLY.

Contents of No. 153 (July).

	PAGE
The Karkinokosm, or World of Crustacea.—IV. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S. (*Illustrated*)	145
A Classic Legacy of Agriculture.—II. By John Mills. (*Illustrated*)	148
"The Mimic Fires of Ocean." By G. Clarke Nuttall, B.SC.	150
The Petroleum Industry.—II. By George T. Holloway, ASSOC. R.C.S. (LOND.), F.I.C. (*Illustrated*)	151
On the Eclipse Theory of Variable Stars. By Lieut.-Colonel E. E. Markwick, F.R.A.S. (*Illustrated*)	153
The Recent Eclipse.—The Lick Photographs of the Corona. By E. Walter Maunder, F.R.A.S.	155
Notices of Books	156
Obituary	158
Letters	159
Science Notes (*Illustrated*)	159
Self-Irrigation in Plants. By the Rev. Alex. S. Wilson, M.A., B.SC. (*Illustrated*)	160
British Ornithological Notes	162
Botanical Studies.—IV. Mnium. By A. Vaughan Jennings, F.L.S., F.G.S. (*Illustrated*)	163
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.	166
The Face of the Sky for July. By A. Fowler, F.R.A.S.	167
Chess Column. By C. D. Locock	167
PLATE.—The Lick Photographs of the Corona.	

Contents of No. 154 (August).

	PAGE
The Petroleum Industry.—III. By George T. Holloway, ASSOC. R.C.S. (LOND.), F.I.C. (*Illustrated*)	169
An Old-World Highland. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated*)	170
Self-Irrigation in Plants.—II. By the Rev. Alex. S. Wilson, M.A., B.SC. (*Illustrated*)	173
Celebes: a Problem in Distribution. By R. Lydekker, B.A., F.R.S.	175
British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.	177
"Insect Miners." By Fred. Enock, F.L.S., F.E.S., etc. (*Illustrated*)	178
Notices of Books	179
Letters	181
Artificial Faculæ. By the Rev. Arthur East. (*Plate*)	183
The Objective Prism, the Flash, and the Reversing Layer. By E. Walter Maunder, F.R.A.S. (*Illustrated*)	184
Alexander Goodman More	187
How to Photograph through a Fly's Eye. By Fred. W. Saxby. (*Illustrated*)	187
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.	189
The Face of the Sky for August. By A. Fowler, F.R.A.S.	191
Chess Column. By C. D. Locock	191
PLATE.—Artificial and Natural Faculæ.	

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